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# CONTRACTILITY OF THE HUMAN UTERUS RECORDED BY NEW METHODS


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PROGRESS in the practice of obstetrics requires better knowledge concerning uterine contractility. The normal and abnormal patterns of contractility as well as the effect of certain drugs upon the uterine muscle must be accurately determined. In this study we have used new methods to record the strength of the contractions of the uterus. We shall present the results obtained in the first 120 clinically normal cases; later we shall publish a report of the results obtained in the presence of some pathological conditions and with the use of several drugs.

### TECHNIQUE

*Previous methods of tocography.* Among the previous methods of tocography are the internal and the external methods and that with the tocodynamometer. The internal methods (4, 14, 15, 24, 25, 33) record the pressure exerted by uterine contractions on a balloon placed in the lower uterine segment during the first stage of labor. The external methods (3, 7, 8, 9, 11, 13, 17, 23, 26, 30) record, from only one point on the abdomen, the total change in shape and position of the uterus with each contraction. With the tocodynamometer of Reynolds, Heards, Bruns and Hellman (20–22) records are made from three points simultaneously—fundus, miduterus, and lower uterine segment—and show the force required to change the shape of the uterus at each point.

With *our methods* record is made of the pressure exerted by contractions of the uterus on the physiological contents of the uterus—ovum, placenta—and that pressure is taken as a gauge of uterine contraction. As a unit of pressure, we use the pressure exerted by a column of water 1 centimeter in height. To record the pressure exerted by contractions of the uterus, we use two methods: The first method consists in recording the pressure exerted on the amniotic sac (pressure of amniotic fluid) and the record is made during pregnancy and during the first and second stages of labor. The second method consists in the recording of placental pressure (blood pressure in placental and cord vessels after birth of child and the clamping of the cord), and the record is made during the third stage of labor. In twin pregnancies it is also used during the second stage of delivery of the second twin.

*Technique of recording amniotic fluid pressure* (Fig. 1). The woman is placed in the supine position. The abdominal skin is disinfected and draped with sterile towels. Puncture is made in the midline at a point that varies with the situation of the placenta and the position of the fetus.[1] Previously novocain has been injected to infiltrate the area from the skin down to the peritoneum. The puncture is made with the apparatus shown in Figure 2. Two areas of resistance are felt, the first as the


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[1]Usually the puncture is made between the umbilicus and the pubis.

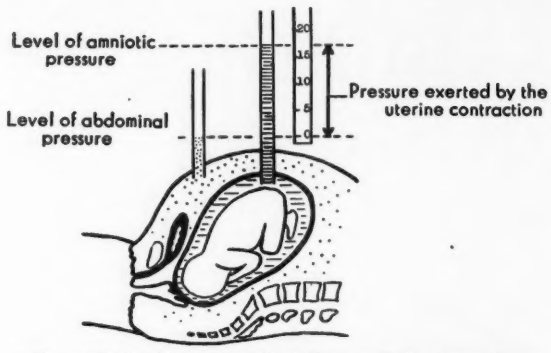


Fig. 1. Basis of the first method. The amniotic pressure (pressure of the amniotic fluid) and the abdominal pressure are recorded simultaneously. At each moment, the difference between them is the "pressure exerted by the uterine contraction."

needle punctures the abdominal wall and the second as the needle punctures the uterine muscle. At this point the needle enters the amniotic cavity and amniotic fluid flows into the glass tube. The level to which the fluid rises indicates amniotic fluid pressure. The level oscillates because of the uterine contractions.

To record the amniotic fluid pressure, the glass tube is replaced with a rubber tube which is connected with a recording manometer. During pregnancy a water manometer is used (Fig. 3); during labor, on account of the great intensity of the contractions, a mercury manometer is employed (Fig. 4).

The whole apparatus is previously sterilized by boiling, and then the system is filled with sterile, apyrogenetic, normal saline solution. For this step a special device, not shown in the illustration, is used. Each manometer is equipped with an ink recording system and operates with very little friction. The speed of the kymograph is 0.5 centimeter per minute. The record is made on ruled graph paper to render easier the reading of the tracing. Figures 12 to 17 show tracings obtained with this method.

*Two important precautions.* 1. If blood comes up into the glass tube when puncture is effected, the placenta has been reached. In this case the needle should be withdrawn without further introduction. Another puncture may be effected in a different place, with caution to avoid the placenta. Puncture of the placenta has in no case brought about harmful consequences either to the pregnant woman or fetus.

2. When the recording is finished and the needle is withdrawn, it is well to exert compression for 5 minutes over the puncture point. Passage of amniotic fluid to the peritoneal cavity, which may cause a painful peritoneal reaction and also reflex uterine contractions, is thus prevented.

*Three interesting details.* 1. The needle may become obstructed by clots in the amniotic fluid. The use of a three way stopcock and of the syringe makes removal of the obstruction easy.

2. The beveled edge of the needle may be obstructed by the umbilical cord or by the fetus but may be freed by slightly moving the needle.

3. In certain cases the recording during labor may become difficult because of the scarcity of amniotic fluid. This problem is solved by injecting into the amniotic cavity 100 to 200 cubic centimeters of sterile apyrogenetic normal saline solution. We have been able to prove that this injection does not modify uterine contractility (2). When scarcity of fluid is caused by rupture of the membranes, to avoid loss of injected fluid, it should not be injected until the head of the fetus obstructs the birth canal.

*Technique of recording abdominal pressure.* When the contents of the urinary bladder is about 30 cubic centimeters, the vesical pressure can be considered as equal to the abdominal pressure. Therefore, instead of recording the abdominal pressure from the peritoneal cavity, we record the vesical pressure. This method has the following advantages: (a) the recording technique is simpler as it requires only the introduction into the bladder of a catheter connected to a manometer (Figs. 3 and 4); (b) the presence of fluid in the bladder makes possible the recording of variations in abdominal pressure caused by the bearing

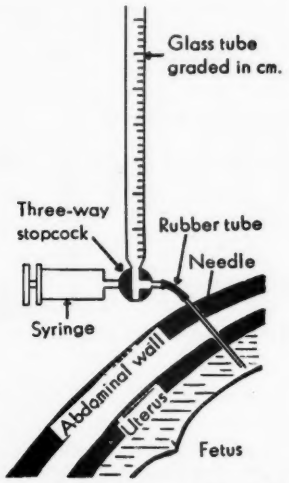


Fig. 2. Instrument for puncture. The needle is gauge 15.

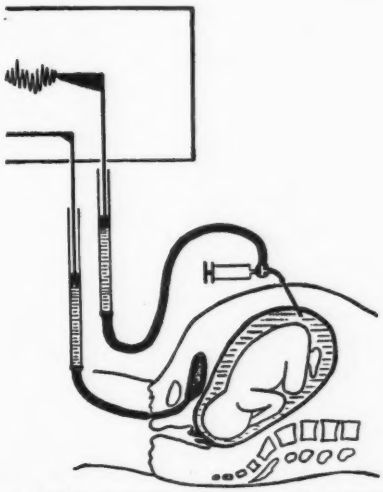

Fig. 3. During pregnancy water manometers are used.

down movements, etc. This procedure would not be possible in the peritoneal cavity because of the absence of fluid. Oscillations in vesical pressure caused by contractions of the urinary bladder are easily recognized.

*Technique of recording placental pressure* (Fig. 5). The second method, the method of recording placental pressure, is used during the third stage of labor (Figs. 6, 7, 8). In twin pregnancies it may also be used during the second stage in delivery of the second fetus (Fig. 9). Immediately after the child is born the cord is clamped (Fig. 6, clamp *D*), 10 centimeters away from the vulva. The umbilical vein is punctured between the clamp and the placenta, with a large trocar, *A*. The vein is adjusted over the trocar with a thread. The trocar is connected with a rubber tube, *B*, to a mercury manometer which records the placental pressure on a kymograph. The uterine contractions compress the placenta and cause an increase in placental pressure which is recorded by the mercury manometer (see Fig. 18). The whole system (manometer, rubber tube, and trocar) is previously assembled and filled at a pressure of 4 centimeters of mercury with a 4 per cent solution of sodium citrate to avoid clotting of the blood within it.

*Technique of measuring pressure exerted by the elastic reaction of the placenta* (Fig. 7). The pressure exerted by the elastic reaction of the placenta is the pressure that remains in the blood contained in the placenta after its delivery. To measure it, the trocar, *A*, is withdrawn from the umbilical vein and is kept at the same level as the placenta. The manometer communicates now with the atmosphere. The level to which the mercury in the manometer descends indicates the amount of the pressure we are determining (see Fig. 18).

*Determination of the level of abdominal pressure* (Fig. 8). The manometer is connected

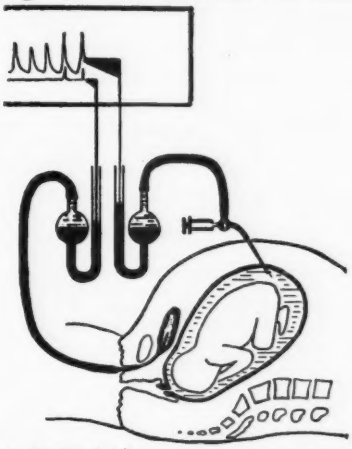

Fig. 4. During labor mercury manometers are used.

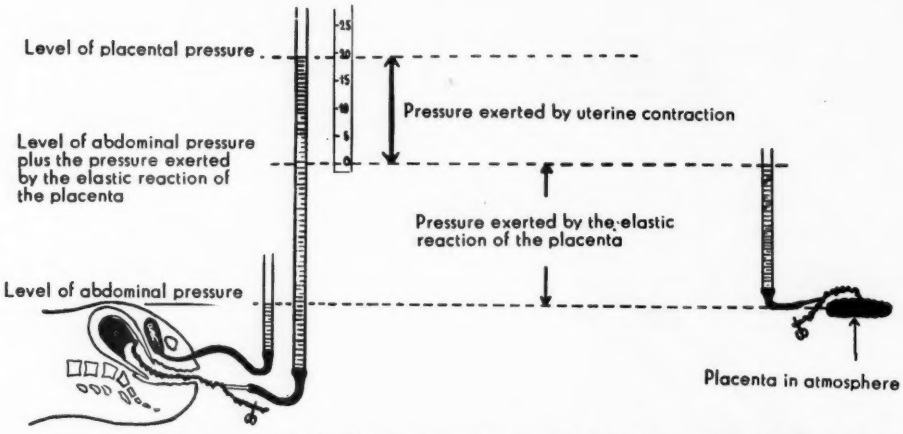
Level of placental pressure
Pressure exerted by uterine contraction
Level of abdominal pressure plus the pressure exerted by the elastic reaction of the placenta
Pressure exerted by the elastic reaction of the placenta
Level of abdominal pressure
Placenta in atmosphere

Fig. 5. Basis of the second method. We call placental pressure the blood pressure in the placental and cord vessels, after the birth of the child and the clamping of the cord. This placental pressure is equal to the addition of three pressures, which are: a, the abdominal pressure; b, the pressure exerted by the uterine contraction; c, the pressure exerted by the elasticity of the placenta.[1] To determine the value of the "pressure exerted by the uterine contraction" we proceed as follows: to the level of the abdominal pressure we add the value of the "pressure exerted by the elastic reaction of the placenta." The new level thus obtained is taken as the "zero" of our scale of pressures. The difference between the placental pressure and this zero, is the value of the pressure exerted by the uterine contraction.

with a catheter which is introduced into the urinary bladder.

ADVANTAGES OF OUR METHODS

1. The method is exact; the contraction is measured by the pressure it exerts.

2. A standard unit of measure is used. Comparison between the different cases is made possible by the use of a standard unit for measuring the contraction. The normal values of uterine contractility as well as alterations in them can be determined.

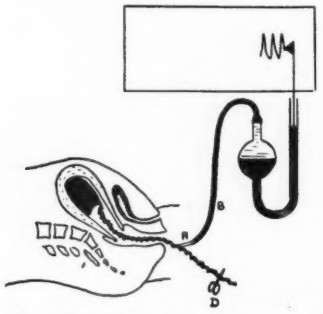


Fig. 6. Recording of the placental pressure during the third stage.

3. The method can be used to determine uterine contractility during pregnancy and during all three stages of labor.

4. The system is highly sensitive; the water manometer records the slightest variation.

5. The method is simple both because of the few instruments required and of the ease in handling them.

6. The method does not affect uterine contractility. This is obvious in the recording of placental pressure. We have also been able to prove that puncture of the uterus which is necessary for the recording of amniotic pressure does not excite the uterine muscle. In a few cases, a slight excitation may be produced at the moment of puncture, but it lasts only a few minutes and so does not affect the recording, which may last for several hours.

7. The making of the record is not disturbed by fetal movements, because they do not alter the amniotic (or the placental) pressure.

8. The breathing of the mother does not affect the recording. Pressure variations

[1]The "pressure exerted by the elastic reaction of the placenta" is caused as follows: when the cord is clamped immediately after the birth of the child, a quantity of blood remains enclosed in the placental and cord vessels, filling and distending them. The elastic reaction of the distended vessels and surrounding tissues imparts to the blood therein contained a certain pressure (3 cm. of Hg).

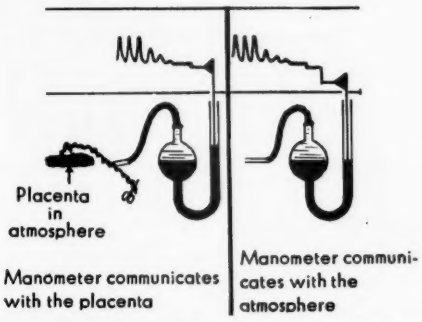


Fig. 7. Measurement of the pressure exerted by the elastic reaction of the placenta.

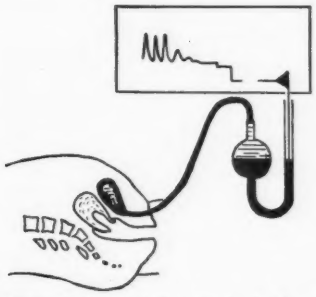

Fig. 8. Determination of the level of the abdominal pressure.

caused by such breathing movements are too fast to be recorded by our methods, which are most sensitive to the slow variations peculiar to movements caused by uterine contractions.

9. The recording of the placental pressure is absolutely *harmless*. The recording of the amniotic pressure necessitates exact attention to all the precautions pointed out in the description of the technique and very careful handling. We have made records of the amniotic pressure in over 140 women without an accident—abortion, premature labor, infection, hemorrhage, etc.

## RESULTS

We have studied uterine contractility in more than 180 women, in the department of obstetrics, Pereira Rossel Hospital, Montevideo. In the present paper only the 120 clinically normal cases are discussed (30 during pregnancy, 90 during labor). In several instances the same woman was studied in different periods of pregnancy and during labor.

*General characteristics of uterine contractility. 1. Permanent rhythmical contractility.* During pregnancy (Figs. 12, 13, 14) and during all three stages of labor (Figs. 15 to 19), the uterus exhibits rhythmical contractions at all times. The rhythmical contractions of pregnancy are continuous with those of the first and second stages of labor, and these with those of the third stage, without any interruption.

*2. Tonus* (Fig. 10). In several tracings obtained by other methods the tonus appears as a more or less straight and horizontal line, between two contractions. In our tracings this horizontal line does not appear, because when one contraction ends, the next one starts, without any noticeable interval between them. Between two contractions, the tonus is reduced to a point, the point at which one ends and the other begins. The "line of tonus" is an imaginary line that unites all these points; it oscillates continually, slowly and smoothly.

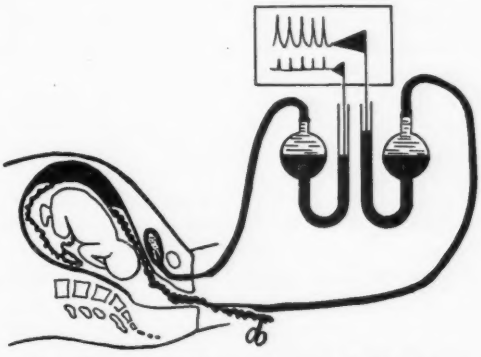

Fig. 9. Recording of placental pressure, in twin pregnancies, during the second stage of the second twin, and the third stage. This technique allows the recording of the uterine contractility during these two periods, with the same method and without interruption. This method has the same basis as the one described before. The technique differs only in the following points: (a) Immediately after the first twin is born, its cord is used to record placental pressure. In order to avoid compression of this cord by the head of the second twin a catheter is introduced into the umbilical vein toward the placenta. This catheter is connected with a mercury manometer. (b) To determine the value of the bearing down movements, the abdominal pressure must be recorded simultaneously with placental pressure.

Fig. 10. The "tonus" and the "line of tonus," by other methods and in our method.

*Uterine contractility during pregnancy* (Figs. 12, 13, 14). Two kinds of contractions are recorded during pregnancy: (1) rhythmical contractions of low intensity (less than 8 centimeters of water) and (2) nonrhythmical contractions of a higher intensity (more than 8 centimeters of water).

*1. The rhythmical contractions of low intensity* have not been described by other authors. Since they are of slight intensity they are not noticed by the pregnant woman or perceived on abdominal palpation. They are not recorded by means of "external" methods; the great sensitiveness of our method, however, has made their recording possible (Alvarez and Caldeyro, 1). We have noted them in all patients studied, from the ninth week up to the end of the pregnancy. They appear continuously without any period of rest. The *intensity* of each contraction varies between 0.3 and 7 centimeters of water (Figs. 12, 13, 14). The average value of all the contractions in one record (Figs. 20 and 21) varies in different cases between 0.5 and 4 centimeters of water. The average value of the *tonus* of each case varies between 4 and 11 centimeters of water (Fig. 20). In one and the same record the tonus may show slow spontaneous oscillations that may vary by 2 centimeters of water. The *frequency* varies between 10 and 30 contractions per 10 minutes, depending on the case (Fig. 21).

We have not been able to find a relationship between the duration of pregnancy and the values of the intensity of the contractions and of the tonus, except in the last 2 weeks of pregnancy when these values increase.

*2. The nonrhythmical contractions of higher intensity* are the Braxton-Hicks contractions (American and English authors) or the "painless contractions of pregnancy" (Latin authors). Because of their higher intensity (more than 8 centimeters of water) they can be recorded

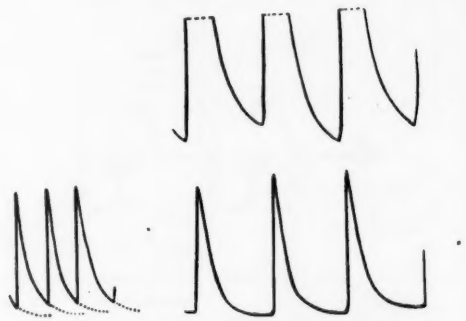

Fig. 11. The shape of the decontraction. The decontraction (curve of relaxation) has an hyperbole-like shape. The longer the following contraction takes, the more completely the decontraction is drawn. If the following contraction appears quickly (i.e., the frequency is high as in curve at left), it comes out of the more or less vertical part of the hyperbole; the tonus appears distinctly as a *point* between the two contractions. (See also Figs. 12, 13, 14, 17.) If the following contraction takes longer (low frequency cases as in curves at right), there is time for the more horizontal part of the hyperbole to be drawn (Fig. 15). It is this part of the decontraction which, in records obtained by other methods, appears as a straight and horizontal line called "tonus." In Figure 16 (representing a case with irregular rhythm), the two possibilities above described, and the intermediate ones, can be distinctly appreciated. The greater the sensitiveness of the manometer, the better the hyperbole-like shape of the decontraction is appreciated. In cases with low frequency, the final part of the decontraction may appear almost horizontal if recorded with a mercury manometer (as in lower right graph); a simultaneous record obtained with a water manometer (13.6 times more sensitive and as shown in upper right graph), proves it is not horizontal but hyperbolic.

by external methods, perceived by abdominal palpation, and the pregnant woman can feel them as a hardening of the uterus. They appear sporadically usually without rhythm. During the first 8 months of pregnancy they occur very infrequently; it sometimes takes a long period to record one. Figure 13 shows one of these contractions. Their frequency increases as pregnancy advances. During the ninth month they are quite frequent but are still without any regular rhythm. It is only in the last 2 weeks before labor that they acquire regular rhythm (Fig. 14).

*Uterine contractility during the last 2 weeks of pregnancy* (Fig. 14). During the last 2 weeks of pregnancy the characteristics of uterine contractility are intermediate between those of pregnancy and those of labor. As labor draws near, uterine contractility increases; Braxton-Hicks contractions become

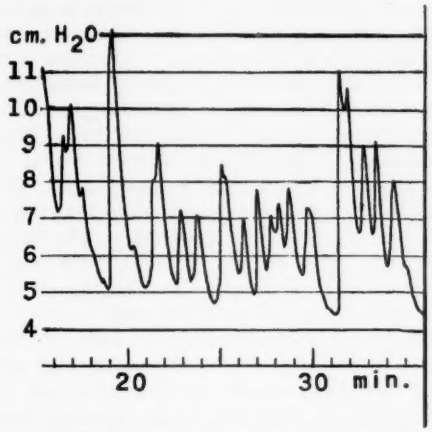


Fig. 12. Tracing made in the third month of pregnancy.

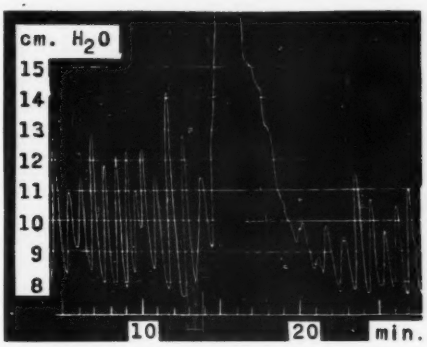


Fig. 13. Tracing made in the seventh month of pregnancy.

stronger and have more regular rhythm. They become more frequent. Between them, feebler contractions are observed. As the frequency of the Braxton-Hicks contractions increases the number of smaller contractions between them decreases.

We calculate that the average value of the *intensity* of the contractions in each case, including all contractions, both the Braxton-Hicks and the small ones, varies with the individual case, between 6 and 35 centimeters of water (Figs. 20 and 21). The average value of the *tonus* in each case varies between 8 and 15 centimeters of water (Fig. 20). In one record tonus may show slow oscillations that may reach to 4 centimeters of water. The *frequency*, including all contractions, varies with the case and averages 3 to 9 contractions per 10 minutes (Fig. 21).

*Uterine contractility during first and second stages of labor.* During the first and second stages of labor the uterus undergoes strong rhythmical contractions (Figs. 15, 16, 17). In normal labor these contractions are regular both in intensity and rhythm. The *intensity* of the contraction varies in different cases between 25 and 70 centimeters of water. Values obtained most frequently are between 40 and 50 centimeters of water (Figs. 20 and 21). The average value of the *tonus* varies in different cases between 8 and 17 centimeters of water (Fig. 20). In one record the tonus may show oscillations that vary as much as 7 centimeters of water. The *frequency* varies, in different cases, between 2 and 6 contractions per 10 minutes (Fig. 21). Values most frequently found are between 4 and 5 contractions per 10 minutes. The rhythmical contractions of the first and second stages are very much alike in intensity, frequency, and tonus.

*Bearing down movements.* During the second stage, the pressure exerted by the abdominal muscles, that

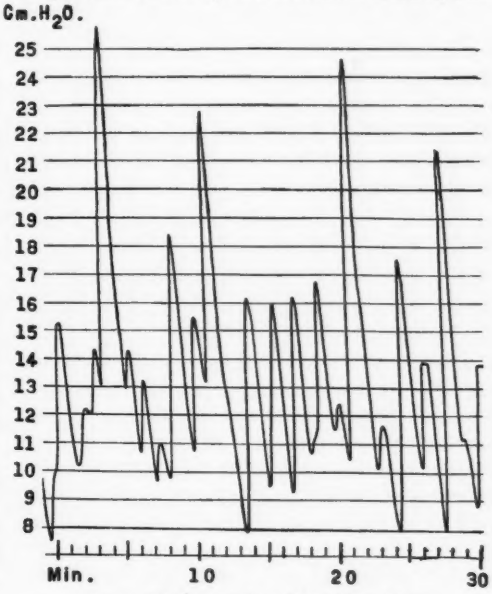


Fig. 14. Tracing made 2 days before labor.

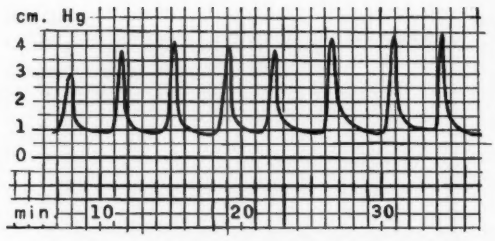


Fig. 15. Tracing obtained during the first stage of labor, with the technique shown in Figure 4 (Case 176). The average values of this record are: intensity, 40 centimeters of water; tonus, 11.5 centimeters of water; frequency, 2.6 contractions per 10 minutes.

is the bearing down movements, is added to the pressure exerted by the uterine contractions. These movements give rise to peaked excursions which appear on the crests of the uterine contractions (Fig. 17). There may be one or more bearing down movements per uterine contraction. The bearing down is also recorded in the tracing of the abdominal pressure, obtained by means of vesical pressure. The *intensity* of the bearing down movements varies greatly and is dependent upon the woman, the instructions of the obstetrician, etc. Values generally obtained are between 20 and 70 centimeters of water, sometimes even higher. Their duration is also variable, but they are always much shorter than the uterine contraction.

*Uterine contractility during the third stage of labor.* To record uterine contractility during the third stage of labor the method used for placental pressure is that shown in Figures 6, 7, and 8, and tracings as shown in Figure 18 are obtained. In twin pregnancies the technique shown in Figure 9 is used and tracings as in Figure 19 are obtained.

Immediately after the birth of the child the uterus continues to perform rhythmical contractions (Fig. 18, $C_1$, $C_2$, etc.) similar to those of the first and second stages; these follow without any interruption. This continuity is clearly seen in the tracing shown in Figure 19, which was obtained with a method (Fig. 9) that permits the recording in an uninterrupted form of the second stage of delivery of the second twin and of the third stage. In no normal case have we been able to record the existence of the so called "period of physiological rest." This is a period described by several authors (10, 12, 16, 18, 19, 27, 28) as starting after the birth of the child, lasting from 5 to 15 minutes, during which time the uterus undergoes no contractions. Our results are in agreement with some radiological (31, 32) and clinical (5, 6) investigations. Contractions of the third stage have the following characteristics. The *intensity* varies between 35 and 60 centimeters of water in different cases (Figs. 20 and 21). The intensity is very similar to that found in the first and second stages. The *frequency* varies in different cases between 2 and 5 contractions per 10 minutes. The value most frequently found is 3 contractions per 10 minutes. It is slightly lower than that of the first and second stages. The *tonus* varies between 5 and 10 centimeters of water in different cases (Fig. 20). Slow oscillations appear that may reach to 6 centimeters of water. Tonus in the third stage is lower than in the second stage, because delivery of the fetus and release of amniotic fluid greatly diminish the volume of the uterine contents. The lowering of the tonus caused by delivery of second twin can be clearly seen in Figure 19.

*Pain.* While the placenta is still within the active segment of the uterus (Fig. 18), the uterine contractions ($C_1$, $C_2$, $C_3$) are painless, in spite of the fact that their intensity is similar to the intensity of the contractions of the first and second stages. It is because they are painless that the contractions have not been noted by many authors (10, 12, 16, 18, 19, 27, 28). Nevertheless they are easily perceivable by abdominal palpation (6).

During descent of the placenta the contractions ($C_4$, $C_5$, etc.) are painful. There is no distinct relationship between the pain and the intensity of the contractions.

## DISCUSSION

1. Because the rhythmical contractions of the human uterus during pregnancy are of slight intensity, they have not previously been recorded by other methods. Their existence is in accord with the general property of visceral smooth muscle which contracts rhythmically and spontaneously. Similar contractions have been described in other hollow viscera and in the nonpregnant uterus. Woodbury, Hamilton and Torpin (33) proved that contractions during labor, impelling the blood from the maternal placenta to the inferior vena cava system, facilitate the venous return to the

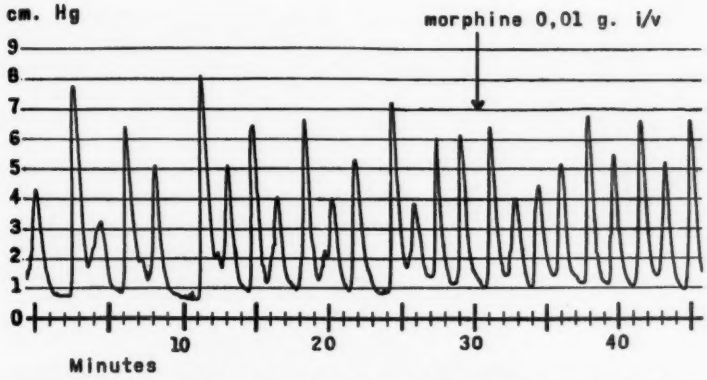


Fig. 16. Tracing obtained during the first stage of labor, with the technique shown in Figure 4 (Case 135). At the beginning of the record, the rhythm is rather irregular. Morphine hydrochloride (0.01 gm.) is injected into the vein of the arm, and the rhythm becomes more regular. The average values of this record are: intensity, 60 centimeters of water; tonus, 15 centimeters of water; frequency, 5 contractions per 10 minutes.

heart. Torpin (29) has proved that the Braxton-Hicks contractions have the same effect at the end of pregnancy. The rhythmical contractions which we have recorded throughout pregnancy must have similar functions, though of minor intensity.

2. In comparing the different periods (pregnancy, the last 2 weeks before labor, and labor) (Fig. 21), a certain relationship between both the intensity and the frequency of contractions is found. Frequency varies approximately in inverse ratio to the square root of the intensity.

3. No distinct relationship exists between the pain and the intensity of the contractions. We have seen that the first contractions of the

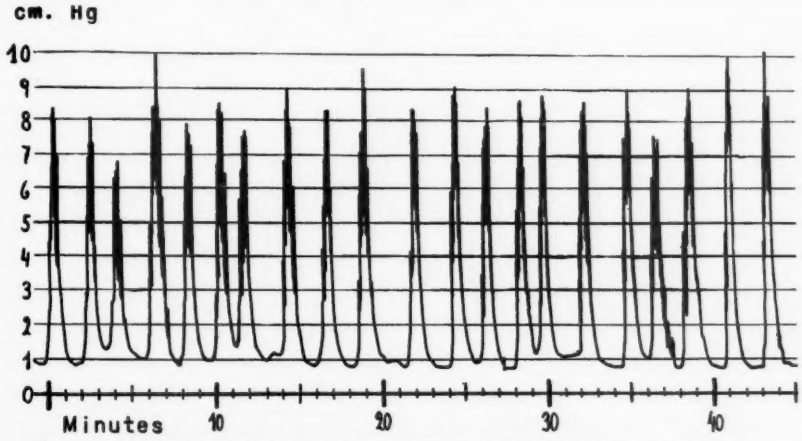


Fig. 17. Tracing obtained during the second stage of labor, with the technique shown in Figure 4 (Case 167). Each uterine contraction is accompanied by several bearing down movements, which give rise to peaked excursions of the recording manometer. The simultaneous record of abdominal pressure has been effaced from the figure for simplicity. The average values of this record are: intensity, 68 centimeters of water; tonus, 11 centimeters of water; frequency, 4.7 contractions per 10 minutes. The intensity of the bearing down movements varies between 20 and 40 centimeters of water.

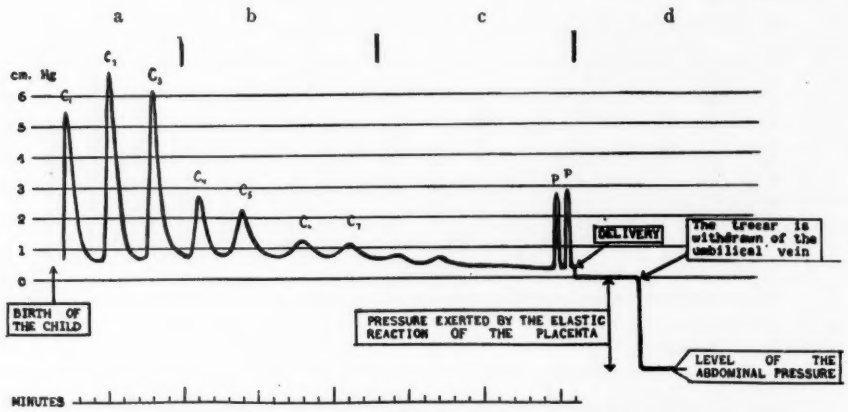


Fig. 18. Tracing of the placental pressure during the third stage. (Obtained with the method shown in Figures 6, 7, and 8.) The active and contractile portion of the uterus is the upper segment. When the whole of the placenta is placed inside this active segment the contractions ($C_1$, $C_2$, $C_3$) are recorded in their entire value. This is the part of the tracing, a, that enables us to study the uterine contractility during the third stage. b, As the placenta comes out of the active segment, the contractions ($C_4$, $C_5$, $C_6$, etc.) have less influence on the placental pressure. When the placenta has totally left the active segment, this influence ceases completely. c, The placenta is now in the birth canal (lower uterine segment, cervix and vagina). There the placenta may be compressed by the bearing down movements ($P$) which may cause its delivery. d, Placenta delivered.

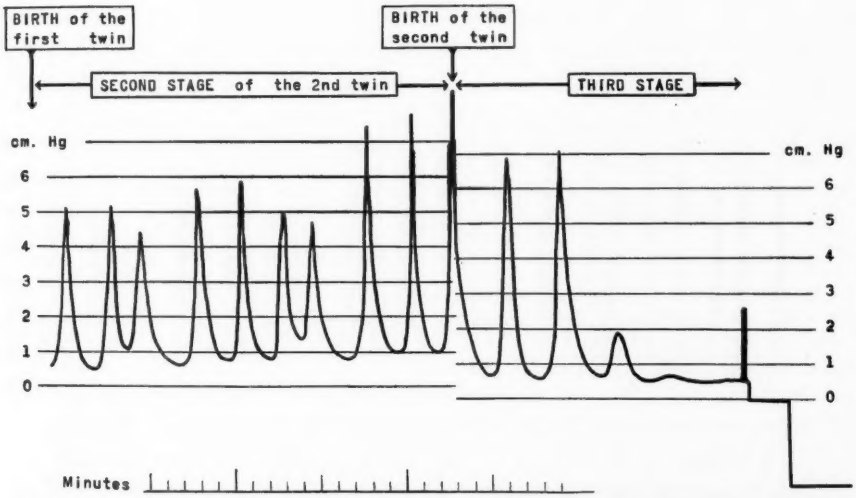


Fig. 19. Tracing of the placental pressure during the second stage of the second twin and during the third stage of labor. Tracing obtained with the technique shown in Figure 9. The continuity of the rhythmical contractions of the second stage with those of the third stage is distinct. The birth of the second twin, diminishing the contents of the abdominal cavity causes a descent in the level of the abdominal pressure (zero line); and diminishing the contents of the uterus, makes the tonus of the third stage lower than that of the second stage.

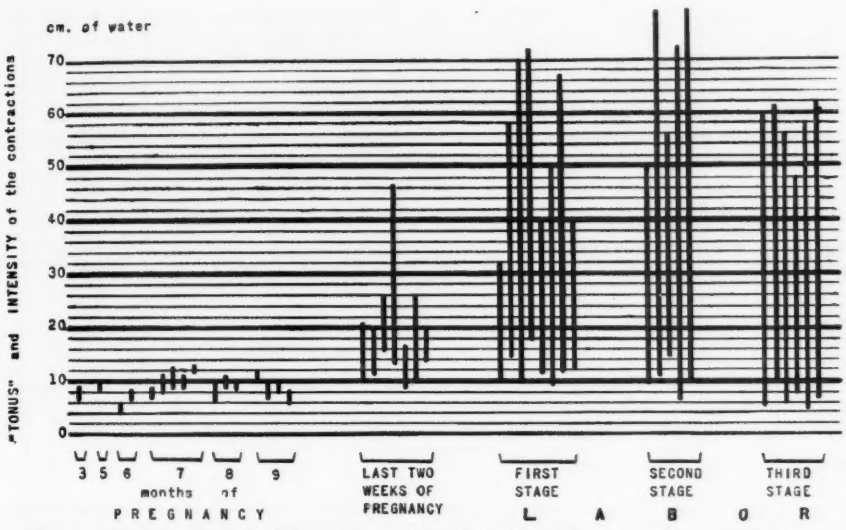


Fig. 20. Average values, in different cases, of the intensity of the contractions and of the tonus. Each vertical line represents one case. The length of the line expresses the average intensity of the contractions of the case. This value is the arithmetical mean of the intensities of all the contractions in an "over 20 minute" period. The distance between the zero and the lower end of the vertical line, represents the average value of the tonus of the case. This value is the arithmetical mean of all the distances between the zero and the points of tonus (the lower points between the contractions). Both the average intensity and average tonus values are determined in the same part of the tracing.

third stage of labor (Fig. 18, $C_1$, $C_2$, $C_3$) are painless despite the fact that they are as intense as those of the first and second stages. Something similar occurs with the contractions in the days preceding labor. These two facts indicate that no definite relationship exists between the pain that accompanies the contraction and the intensity of the contraction. To explain this fact we suggest the following hypothesis:

The pain that accompanies the contraction may not be due to the contraction itself but to some concomitant phenomenon, such as distention of other tissues caused by the contraction; for instance, during the first stage the distention of the cervix; during the second stage, the distention of the birth canal, caused by the pushing of fetus by contractions.

In the days preceding labor the contractions, notwithstanding their high intensity are painless, because they do not cause distention. The pain begins when distention of the cervix starts.

The first contractions of the third stage (Fig. 18, $C_1$, $C_2$, $C_3$) though as strong as those of the first and second stages, are painless, because the placenta remains in the upper uterine segment. When the placenta separates and descends, pushed by contractions (Fig. 18, $C_4$, $C_5$, $C_6$, etc.) the contractions become painful as placenta distends the birth canal.

4. The strong compression that the first contractions of the third stage of labor exert on the placenta must drive a certain amount of blood to the child. It is therefore advantageous not to clamp the cord too soon after the birth, as suggested by Alt and Windle.

5. These same contractions (Fig. 18, $C_1$, $C_2$, $C_3$) must be the ones that separate the placenta and start its descent. In some cases the contractions that expel the fetus accomplish this task.

## SUMMARY

1. Two new methods for quantitative recording of contractions of the human uterus are described. In both of them the contraction is measured by the pressure it exerts on the physiological contents of the uterus (ovum, placenta). During pregnancy and during the first and second stages of labor the amniotic fluid pressure is recorded. During the third stage the placental pressure—blood pressure in placental vessels—is recorded.

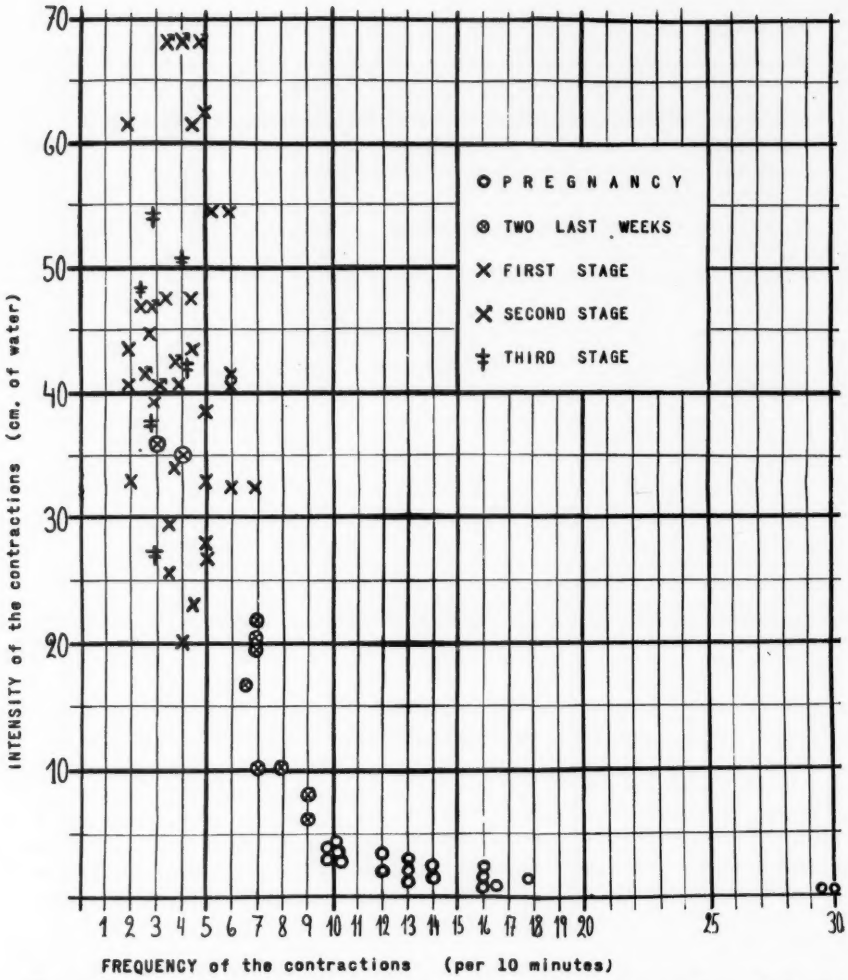


Fig. 21. Relationship between the intensity and the frequency of the contractions. Each point represents one case. The average intensity and average frequency of the case are determined in as long as possible periods of the tracing, always over 20 minutes. More complete and detailed statistical data will be published in another paper.

2. Results obtained in the first 120 clinically normal cases studied are presented. During pregnancy and all three stages of labor the uterus always exhibits rhythmical contractions without any interruption. The rhythmical contractions of pregnancy have not been described heretofore.

3. The patterns of uterine contractility more frequently found during pregnancy and the three stages of labor are described. In each period the values of the intensity and frequency of the contractions and of tonus are:

*Intensity* varies during pregnancy from 0.5 to 4 centimeters of water; during last 2 weeks of pregnancy, between 6 and 35 centimeters of water; during first and second stages, between 25 and 70 centimeters of water; during third stage from 35 to 40 centimeters of water.

*Frequency*, contractions per 10 minutes: during pregnancy 10 to 30; 2 last weeks of pregnancy, 3 to 9; first and second stages of labor, 2 to 6; third stage of labor, 2 to 5.

*Tonus* during pregnancy varied from 4 to 11 centimeters of water; 2 last weeks 8 to 15 centimeters of water; first and second stages, 8 to 17 centimeters of water; third stage, 5 to 10 centimeters of water.

4. The following subjects are discussed: circulatory function of the rhythmical contractions during pregnancy; relationship between intensity and frequency of contractions; absence of definite relationship between pain accompanying contractions and the intensity of the contraction; functions of the first contractions of third stage.

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# INTERTROCHANTERIC FRACTURES OF THE FEMUR

## An Analysis of the End Results of 126 Fractures Treated by Various Methods

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UNTIL recent years intertrochanteric fractures have been treated "conservatively" by the employment of casts and traction (1, 5, 7, 8, 9). The surgical approach to this type of fracture has lagged far behind the development of internal fixation devices for fractures of the surgical neck of the femur. This attitude probably developed because intertrochanteric fractures united in most instances regardless of the method of treatment. The morbidity and mortality rates, however, were alarmingly high. Morris reported a mortality rate of 44 per cent in 16 consecutive cases in which the fracture was treated prior to 1940 by the well leg traction, cast, and Russell traction methods respectively.

In those patients that survived, malunion of the fracture was reported in a surprisingly great number of patients. In seeking to improve the treatment several methods of surgical treatment have been advocated, some advantages over the traction and cast methods of treatment being claimed for each (2, 4, 10, 12).

With this controversy in mind we decided to review all cases in which intertrochanteric fractures of the femur were treated at the Mayo Clinic, between January 1, 1938, and December 31, 1946, inclusive.

We have found only few series of reported cases of intertrochanteric fractures treated by several conservative and surgical methods in which the end-results have been compared. After studying this series of cases in which the patients have been treated by several methods we hope to be able to draw some conclusions regarding the most satisfactory method of treatment to employ in this type of fracture.

From the Section on Orthopedic Surgery, Mayo Clinic and Mayo Foundation.

### MATERIALS AND METHOD OF STUDY

All records of cases bearing the diagnosis of intertrochanteric fracture of the femur seen at the Mayo Clinic between the foregoing years were drawn from the files. Each history was carefully reviewed and summarized. All roentgenograms were scrutinized in an effort to classify the type of fracture, the success of the reduction, the type of fixation if any and if there was roentgenographic evidence of solid union. Any degree of malunion, and so forth, was recorded.

After the foregoing investigation follow-up letters were sent to all patients and pertinent questions regarding their present status were asked. Whenever possible, we re-examined the patients so that the end-result might be better ascertained.

The total number of patients studied was 126. One of these patients had 2 fractures treated during this period, which made the total number of fractures to be evaluated 127. Of these 126 patients, 122 (96.8 per cent) were followed for a sufficiently long period so that the end-result could be evaluated; the shortest follow-up period was 3 months and the longest period was 11 years, with an average of 3 years.

### CLASSIFICATION OF THE TYPE OF FRACTURE

The fractures were placed within one of three major groups. The group 1 fractures were those with a single fracture line without comminution and with the lesser trochanter undisturbed. The group 2 fractures were those with a single fracture line between the trochanters and with some comminution of the lesser trochanteric region. The group 3 fractures included those with marked comminution, and usually with marked displacement, of the fragments. This latter group in-

cluded 2 so called "reversed intertrochanteric fractures" (13).

### METHOD EMPLOYED TO EVALUATE END-RESULTS

In order to evaluate the end-results as carefully as possible the following categories were selected:

1. *Excellent.* Patients with the fracture healed in an anatomic position, the hip completely asymptomatic and the patient able to go up and down stairs unaided.

2. *Good.* These patients were found to have solid union of the fracture both clinically and roentgenologically and were able to walk on smooth surfaces unaided. There usually was a slight degree of coxa vara with residual shortening. Some of these patients had a slight limitation of hip motion.

3. *Fair.* These patients also had solid union of the fracture but with some residual pain in the hip on walking. They were incapacitated slightly.

4. *Poor.* In this classification we placed those patients who, for one reason or another, were never able to walk without crutches, continued to have moderate pain and were totally incapacitated for work.

5. *Fatal.* In this group is included any patient who died at some time prior to clinical or roentgenologic evidence of union of the fracture. Some of these deaths occurred while the patients were hospitalized and others at their homes.

### CLINICAL OBSERVATIONS

Cleveland, Bosworth, and Thompson stated: "These elderly people represent a veritable museum of pathologic changes, antedating their trauma." Our findings certainly concurred, as many of the patients in this series presented severe cardiac, renal, metabolic, and senile manifestations. Many were disorientated, incontinent, febrile, acidotic or decompensated on admission to the hospital and all presented difficult nursing problems from the beginning. Most of the patients stated that a fall in their own home had produced their injury.

*Age.* The patients ranged in age from 5 to 94 years with an average age of 71.9 years. One hundred and five (83 per cent) of our patients were more than 60 years of age. Table I shows the distribution of patients by age.

TABLE I.—AGE INCIDENCE OF INTERTROCHANTERIC FRACTURES

| Age, years | Patients | Per cent of 126 patients |
|---|---|---|
| 0–10 | 1 | 1 |
| 11–20 | 1 | 1 |
| 21–30 | 0 | 0 |
| 31–40 | 3 | 2 |
| 41–50 | 1 | 1 |
| 51–60 | 15 | 12 |
| 61–70 | 22 | 17 |
| 71–80 | 41 | 32 |
| 81–90 | 35 | 28 |
| 91–100 | 7 | 6 |
| Total | 126* | 100 |

*Of these 126 patients 127 fractures were treated.

*Sex.* The ratio of females to males was 2 to 1 with 84 females to 42 males in this series.

*Location.* Sixty-two of the fractures were found to involve the right femur while 65 were on the left.

*Classification.* Fifty-five of the fractures were found to be of the simple group 1 type. Twenty-six were placed in group 2, and 46 in the severely comminuted displaced type or group 3.

### TREATMENT

The types of treatment carried out fell into two major groups; namely, surgical and nonsurgical. Sixty-three fractures were treated by nonsurgical means whereas 64 were treated by open reduction and some means of internal fixation.

*Nonsurgical cases.* Four methods of treatment were carried out in this group: (1) skin traction only, (2) skeletal traction, (3) cast only, and (4) skin traction plus cast (Hoke Martin). The results of these methods of treatment are shown in Table II.

Sixty-one of 63 patients whose fractures were treated conservatively were traced, the longest period being 10 years and the shortest 4 months with an average period of 4 years. No patients were considered traced unless clinical and roentgenologic end-results were known.

TABLE II.—RESULTS OF NONSURGICALLY TREATED INTERTROCHANTERIC FRACTURES

| Type of treatment | Fractures | | Results | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Traced | Excellent | | Good | | Fair | | Poor | | Died | |
| | | | Number | Per cent* | Number | Per cent* | Number | Per cent* | Number | Per cent* | Number | Per cent* |
| Skin traction only | 28 | 26 | 11 | 42 | 4 | 15 | 3 | 12 | 0 | 0 | 8 | 31 |
| Cast | 24 | 24 | 10 | 42 | 6 | 25 | 2 | 8 | 2 | 8 | 4 | 17 |
| Skeletal traction | 6 | 6 | 2 | 33 | 2 | 33 | 0 | 0 | 0 | 0 | 2 | 33 |
| Hoke Martin traction cast | 5 | 5 | 0 | 0 | 2 | 40 | 1 | 20 | 1 | 20 | 1 | 20 |
| Total | 63 | 61 | 23 | 37 | 14 | 23 | 6 | 10 | 3 | 5 | 15 | 25 |

*Per cent of traced.

The average age of those patients treated by conservative means was 73.6 years. Of the group of 61 patients whose fractures were treated by these means and who were traced, 37 (60 per cent) obtained an excellent or good result. Although 37 of these patients obtained good or better results 19 of the 37 (51 per cent) did have some degree of malunion (coxa vara) that produced varying degrees of true shortening of the extremity. The average stay in the hospital was 79 days, the shortest stay being 13 days and the longest 602 days.

The type of fracture treated by these methods did not seem to bear any relationship to the end-results obtained, for the proportion of good or excellent results found in group 3 was equal to that in groups 1 and 2.

Eighty-two per cent of these patients were treated after 1940, and the supportive treatment compared favorably with the treatment afforded the surgical patients before operation.

The review of the records of those patients that survived and were traced revealed that in 18 cases (29 per cent) complications developed at some time during convalescence. These complications were quite variable and consisted of the following, in the order of their frequency: limitation of knee motion in 8, decubitus ulcers in 6, incontinence in 6, cystitis in 4, azotemia in 4, pulmonary edema in 2, bronchopneumonia in 2, thrombophlebitis in 1, and peroneal palsy in 1. It is obvious from the preceding that many patients had more than one complication.

As may be seen in Table II there was an over-all mortality rate of 25 per cent of the patients traced. The average period to elapse from the time of injury until death ensued was 33 days. The most rapid death occurred 8 days after the injury and the most prolonged 144 days. If a patient died prior to roentgenologic evidence of union, the result was considered a fatality. Not all of these deaths occurred in the hospital.

The average age of the patients treated conservatively who died was 81.3 years. A résumé of data on the patients that died is shown in Table III.

*Surgical cases.* The following program was carried out for the care of the 64 fractures treated surgically.

Preoperative care. Immediately on admission to the hospital the patients were administered an appropriate dose of morphine hypodermically to relieve pain. This was followed by both anteroposterior and lateral roentgenograms of the injured hip and of other regions of the body if indicated. The injured limb was then immobilized in Buck's extension apparatus, moleskin adhesive being used for traction and a nonrotating foot splint to prevent rotation. About 6 pounds (about 2.7 kgm.) of weight was used for traction. All patients were then seen by an internal medical consultant and any prevailing or impending conditions requiring treatment were cared for. (We feel, as do Hammond and Cady, that this close co-operation between the medical and the surgical staff is essential.) Operation was performed without undue delay; however, in our series we found that from 3 to 7 days were required to place the patient in an optimal condition for operation.

TABLE III.—SUMMARY OF THE PATIENTS TREATED BY CONSERVATIVE MEANS WHO DIED

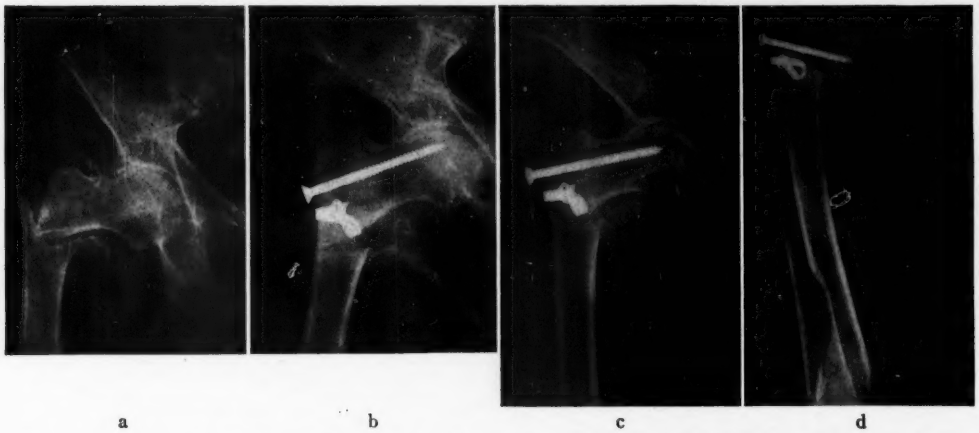
| Age, yr. | Sex | Type of fracture | Type of treatment | Date of injury | Date of death | Condition on admission | Cause of death |
|---|---|---|---|---|---|---|---|
| 87 | F | Group 2 | Skin traction | 2- 7-42 | 2-16-42 | Semicomatose | Bronchopneumonia |
| 77 | M | Group 1 | Skin traction | 2-13-42 | 6-13-42 | Hypertension | Hypertensive cardiovascular disease |
| 85 | M | Group 1 | Skeletal traction | 12-14-40 | 1- 9-41 | Azotemia, Cheyne-Stokes respiration | Coronary occlusion |
| 79 | F | Group 1 | Skeletal traction | 10-12-40 | 10-22-40 | Bilateral chronic lymphedema | Coronary occlusion? |
| 79 | F | Group 1 | Double spica cast | 9- 7-40 | 9-17-40 | Obesity, rheumatism | Pulmonary embolism |
| 81 | M | Group 1 | Skin traction | 3-17-40 | 4- 3-40 | Senility, disorientation, incontinence, azotemia | Bronchopneumonia |
| 79 | M | Group 3 | Skin traction | 10- 7-40 | 11-13-40 | Azotemia | Bronchopneumonia |
| 84 | F | Group 3 | Skin traction | 7- 5-39 | 8- 6-39 | Pneumonia | Bronchopneumonia |
| 77 | F | Group 2 | Double spica cast | 5-29-42 | 10-10-42 | Metastatic carcinoma of breast | Generalized metastatic adenocarcinoma |
| 84 | F | Group 1 | Skin traction | 6-26-43 | 7-21-43 | Cardiac decompensation | Cardiac failure |
| 85 | F | Group 1 | Double spica cast | 1- 8-43 | 4- 9-43 | Azotemia | Unknown |
| 74 | F | Group 1 | Double spica cast | 2-14-45 | 3-10-45 | Subdural hematoma? | Bronchopneumonia |
| 90 | M | Group 2 | Skin traction | 9-24-45 | 10- 2-45 | Azotemia, diabetes mellitus | Renal insufficiency |
| 75 | M | Group 2 | Skin traction | 12-22-45 | 1-29-46 | Hypertension, azotemia | Coronary occlusion |
| 84 | M | Group 2 | Double spica cast | 2-24-43 | 9- 3-43 | Disorientation | Unknown |

On the night preceding operation the patient was given a cleansing enema, and 1½ grains (about 0.1 gm.) of sodium seconal by mouth. The blood grouping and Rh factor were determined. The administration of sodium seconal was repeated on the morning of operation and the perineum and thigh were shaved. When the patients were called to the operating room they were given a hypodermic consisting of morphine and atropine. After the patient had been anesthetized on the surgical cart he was placed on a fracture table. (Thirty-eight patients underwent spinal anesthesia, 18 had intravenous sodium pentothal, 6 had local procaine hydrochloride, and 2 had nitrous oxide and ether.)

The operative technique. The entire thigh and perineum were scrubbed with soap and water for 5 to 10 minutes and the skin was cleansed with 70 per cent alcohol, ether, and merthiolate. Portable x-ray machines were draped so that the reduction and surgical procedure could be followed roentgenologically with a minimum of delay.

Although several methods of internal fixation were used the surgical technique was essentially the same. The fracture was exposed by a longitudinal lateral incision which extended from the greater trochanter down to about midway of the thigh. The tensor fasciae latae and vastus lateralis muscles were split in a longitudinal direction. The fracture was inspected and reduced under direct vision by traction and rotation. In most instances small drill holes were placed through the cortex just below the greater trochanter to prevent further comminution of the fracture if a blade plate was to be inserted. The appropriate internal fixation device was then selected, bent to the proper angle and inserted with the fracture visible and the position of the neck determined by the index finger to insure its proper placement. Both anteroposterior and lateral roentgenograms were taken to insure proper position.

The rigidity of the fixation was checked by moving the extremity about prior to closure of the incision. The incision was then closed in layers and a light dressing applied. In some instances 6 pounds (about 2.7 kgm.) of moleskin traction and a nonrotating foot splint were applied for a few days to prevent excessive rotation. If the patient's general condition warranted it, a transfusion of whole blood



a b c d

Fig. 1. a, Anteroposterior view of the right hip of a woman aged 83 years, showing an intertrochanteric fracture of the femur, group 3. b, Anteroposterior view of the hip in the same case after open reduction and insertion of one vitallium wood screw and one Parham band for internal fixation. The patient was immobilized in a double spica cast postoperatively. c, The same case one month after operation, showing a moderate degree of coxa vara due to inadequate fixation of the fracture. d, The same case three years after operation, showing union of the fracture in an extreme degree of coxa vara. The result was considered only fair owing to the marked shortening of the extremity; however, the patient was able to walk in her own home unaided, but was readmitted to the hospital for treatment of the spiral fracture of the femoral shaft shown here, which was due to a fall.

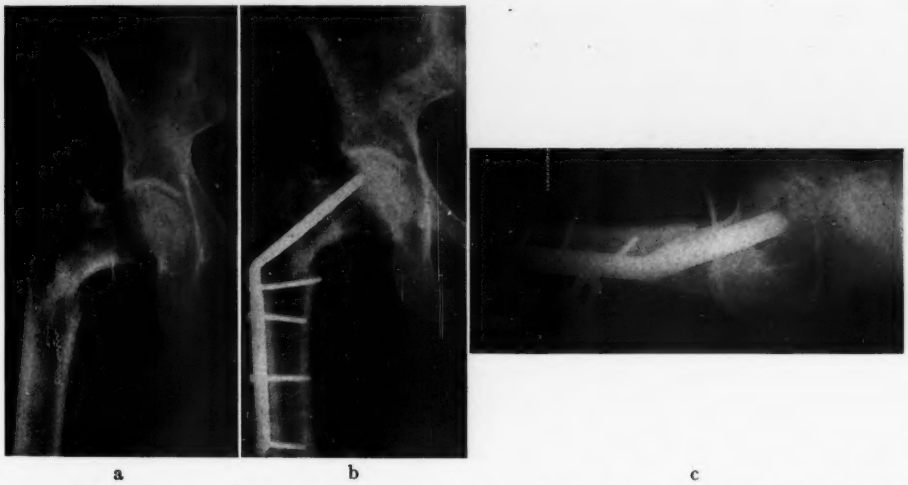
was begun during the operation or immediately postoperatively.

Postoperative care. Postoperatively the patient was encouraged to sit up in bed and 24 to 48 hours after operation he was placed in a wheel chair. During this period the patient's urinary output was measured daily, and when it was less than 1,000 cubic centimeters per 24 hours, intravenous administration of fluids was begun. The patients were observed very closely for the first few days after operation. Here again close co-operation of the internist and the orthopedist is essential, as we have found that the internist is of material aid in caring for the patient's general condition. Unless the patient is properly cared for, the presence of such general diseased conditions as diabetes, cardiac decompensation, acidosis or azotemia will certainly result in a fatal termination.

TABLE IV.—RESULTS OF SURGICALLY TREATED INTERTROCHANTERIC FRACTURES

| Type of treatment | Fractures | | Results | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Traced | Excellent | | Good | | Fair | | Poor | | Died | |
| | | | Number | Per cent* | Number | Per cent* | Number | Per cent* | Number | Per cent* | Number | Per cent* |
| Blount or Moore blade plate | 39 | 37 | 23 | 63 | 6 | 16 | 2 | 5 | 2 | 5 | 4 | 11 |
| Vitallium wood screws | 10 | 10 | 6 | 60 | 2 | 20 | 1 | 10 | 1 | 10 | 0 | 0 |
| Neufeld nail | 7 | 7 | 3 | 43 | 3 | 43 | 0 | 0 | 0 | 0 | 1 | 14 |
| Parham bands | 4 | 4 | 2 | 50 | 1 | 25 | 1 | 25 | 0 | 0 | 0 | 0 |
| Multiple pins | 2 | 1 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Thornton blade plate | 1 | 1 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vitallium plate | 1 | 1 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 64 | 61 | 37 | 60 | 12 | 20 | 4 | 7 | 3 | 5 | 5 | 8 |

*Per cent of traced.

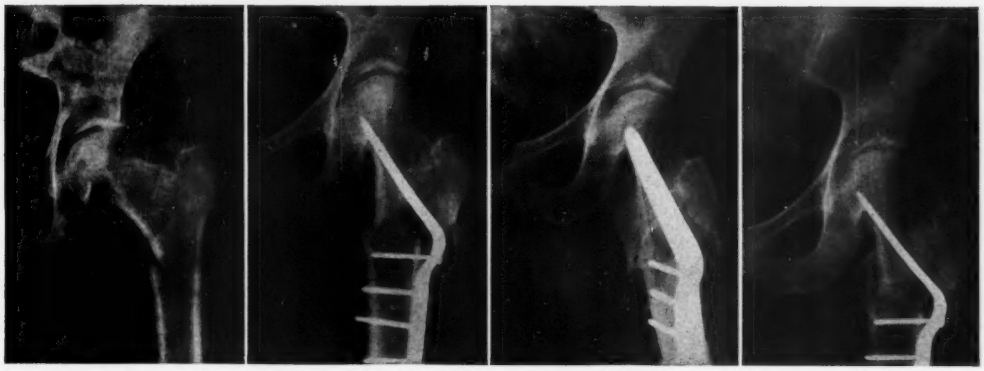


a b c

Fig. 2. a, Roentgenogram of the anteroposterior aspect of the right hip of a woman, aged 78 years, showing a comminuted, displaced intertrochanteric femoral fracture, classified as group 3. b, Anteroposterior view in the same case, showing the fracture held by a Moore blade plate. c, Lateral view in the same case. Two and one-half years after performance of the operation this patient wrote that she had no difficulty in climbing stairs unaided, there was no shortening of the extremity, and the hip was asymptomatic.

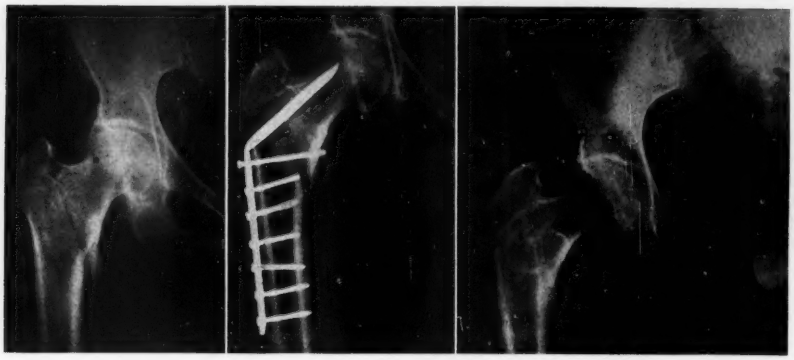
Close co-operation with the nursing staff is also necessary in order to prevent such complications as decubitus ulcers, pulmonary edema, and hypostatic pneumonia. Frequent change of the patient's position, alcohol rubs, the prevention of pressure areas by the use of air cushions, all materially reduce these complications.

The incision was usually dressed on the fifth postoperative day. The sutures were removed on or about the fourteenth day. The nonrotating foot splint and traction were



a b c d

Fig. 3. a, Anteroposterior view of the left hip of a woman, aged 53 years, showing an intertrochanteric fracture of the femur, group 2. b, Anteroposterior view in the same case, showing the fracture held by a Blount osteotomy blade plate. Notice that considerable comminution of the fracture has been produced by the insertion of the blade. c, Slightly oblique view in the same case, showing the position of the blade plate. d, Anteroposterior view in the same case taken 2 months after operation, showing satisfactory progression of the healing of the fracture. Union was complete 6 months after operation and the result was considered excellent.



a b c

Fig. 4. a, Anteroposterior view of the right hip of a man, aged 35 years, showing a simple intertrochanteric fracture, group 1. b, The same case, showing the fracture held securely by a Moore blade plate. c, The same case shown 6 months after operation with the fracture healed in an anatomic position and the blade plate removed. An excellent result was obtained.

usually discarded before the removal of the sutures and more active exercises were encouraged. If the patient's general condition warranted it, he was encouraged to walk on crutches with no weight bearing. If adequate care could be maintained at home the patient was dismissed from the hospital but instructed to return to the clinic for regular follow-up visits. The average follow-up of the patients traced was 31 months. The shortest period followed was for 3 months and the longest 11 years.

The types of internal fixation used. All patients treated surgically underwent open reduction of their fractures. The type of internal fixation used depended on the surgeon and the type of fracture encountered at the operation.

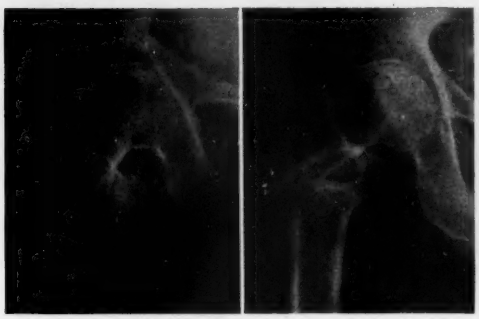
In our series of 64 fractures treated surgically the most frequent procedure was to use a Moore or Blount type of blade plate for internal fixation. This method was used in 39 cases, while vitallium wood screws were used in 10, a Neufeld nail was used in 7, Parham bands were used in 4, multiple pins in 2, and a Thornton nail and vitallium plate were used in 1 case each.

The results obtained from these methods may be seen in Table IV.

Comment on surgically treated patients. The average age was 70.5 years with the youngest patient 31 and the eldest 92 years of age. Sixty-one of these patients were traced and 49 fractures (80 per cent) obtained an excellent or good result. Of the total number that obtained good or better results 75 per cent were considered excellent as compared to 25 per cent with a good result. The average stay in the hospital for the group was 75 days, the shortest stay was 15 days, and the longest 324

TABLE V.—SUMMARY OF THE FATAL CASES IN WHICH THE PATIENT WAS TREATED SURGICALLY

| Age, yr. | Sex | Type of fracture | Type of treatment | Date of injury | Date of death | Preoperative condition | Cause of death |
|---|---|---|---|---|---|---|---|
| 82 | F | Group 1 | Neufeld nail | 4- 7-44 | 4-15-44 | Azotemia | Operative shock |
| 83 | M | Group 2 | Moore blade plate | 12-25-45 | 1-18-46 | Azotemia, senility, disorientation | Uremia, bronchopneumonia |
| 90 | F | Group 1 | Moore blade plate | 1-20-46 | 3-20-46 | Senility | Unknown |
| 81 | F | Group 1 | Moore blade plate | 2-20-45 | 5- 6-45 | Azotemia, incontinence | Bronchopneumonia |
| 85 | F | Group 2 | Moore blade plate | 4-29-46 | 5-16-46 | Senility | Pulmonary embolism |



a b

Fig. 5. a, Anteroposterior view of the right hip of a woman, aged 85 years, showing an intertrochanteric fracture, group 3, as it appeared on admission. b, The same hip 3 months later, showing almost complete bony union in a slight malposition. This patient was treated with a single spica cast for immobilization. The end-result was good.

a b

Fig. 6. a, Anteroposterior view of the left hip of a woman, aged 82 years, showing an intertrochanteric fracture, group 2, without displacement. b, The same case, 3 months later, showing the fracture held in good position by one Parham band. Union of the fracture is almost complete at this early date.

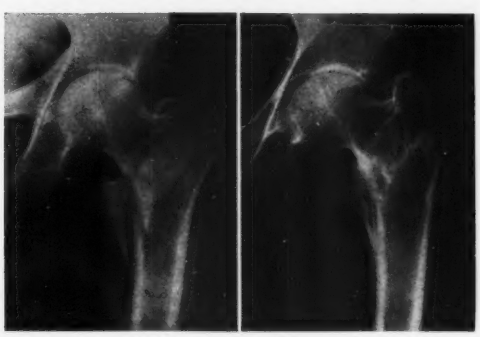
days. The latter patient, as well as others in this group, was obviously a boarder as a result of his dependency.

There was a slightly higher percentage of good or excellent results among those patients with the more comminuted type of fracture. This probably resulted from a more adequate type of internal fixation necessarily used in these cases. It obviously would have been impossible to have used Parham bands and vitallium wood screws for adequate internal fixation of the comminuted fractures.

The question: Are the surgical cases selected? frequently arises. Although we must admit that there possibly was a certain degree of selectivity in this series a complete review of the history, general condition of the patient on admission, and their hospital care did not reveal any significant difference in those patients treated conservatively and those treated surgically.

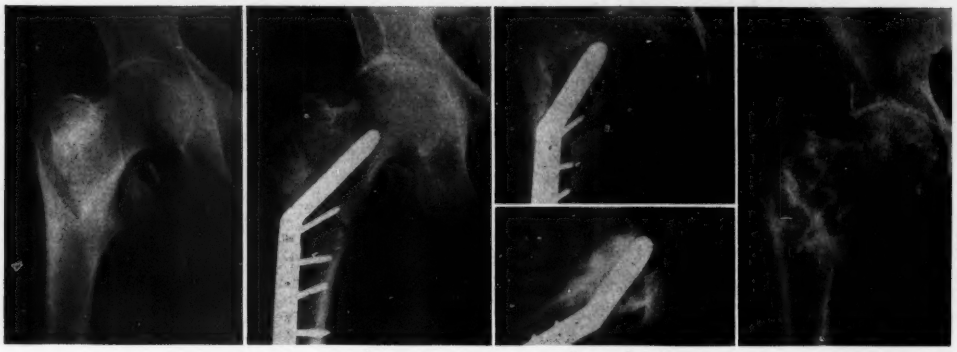
What was the significance of the type of fixation used? Seven different methods of internal fixation were used. Three methods were used in too few patients to enable one to arrive at any definite conclusions. The most frequent type of fixation was the use of the Moore or Blount blade plate with 39 fractures treated. There were 29 excellent or good results in this group for a total of 79 per cent of those traced. In 10 fractures multiple vitallium wood screws were used with 80 per cent obtaining excellent or good results. Seven fractures were fixed with a Neufeld nail with a total of 86 per cent excellent or good results. Only 4 fractures were held by means of Parham bands with 75 per cent excellent or good results.

Only sixty-five per cent of the surgically treated patients were treated in 1943 or later, a fact which partially explains the marked variation in the type of internal fixation used. Although the number of good end-results obtained from the various groups of surgically



a b

Fig. 7. a, Anteroposterior view of the left hip of a woman, aged 66 years, showing a fracture, group 3. b, The same case, showing the fracture healed in a slightly varus position 5½ years after injury. The only treatment was moleskin traction, and the end-result was considered excellent.



a b c, above; d, below e

Fig. 8. a, Anteroposterior view of the right hip of a man, aged 55 years, showing an intertrochanteric fracture, group 2. b, The same case, showing the fracture held in position by a Moore blade plate. c, The same case 6 months after performance of the operation, showing slight coxa vara and anterior displacement of the blade. d, Lateral view in the same case. e, Anteroposterior view of the hip which was taken 15 months following injury and after the blade plate had been removed. The end-result was considered good.

treated patients were essentially the same, some degree of coxa vara developed in fewer cases when a blade plate was used than when another type of treatment was selected.

Complications. Five of these patients died, with a mortality rate of 8 per cent for the 61 patients traced. A summary of the fatal cases is given in Table V.

The average number of days the patients survived from the date of injury was 30. The most rapid death occurred 8 days after injury and could be definitely attributed to the shock of the operation. One patient succumbed on the seventy-fifth day after injury. The complications occurring in the patients that survived are as follows:

In 7 patients complications developed that were not directly due to the operation. These consisted of decubitus ulcers in 5, incontinence in 4, cardiac decompensation in 1, thrombophlebitis in 1, bronchopneumonia in 1, and azotemia in 1.

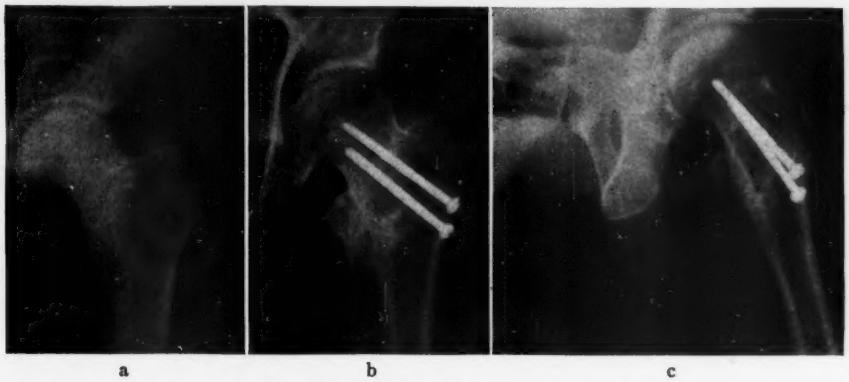
In 7 patients complications developed which were directly due to the operation. Two patients' incisions became infected and drained for 6 and 8 months, respectively. One of these patients ultimately obtained an excellent result and the other a good result. One patient had a resultant stiffness of the knee. In 1 case in which the fracture was fixed by one vitallium wood screw and two Knowles pins, one of the pins "worked out" and was removed at a later date. In 1 fracture fixed with a blade plate the blade penetrated the neck of the femur, allowing varus of the fracture to develop. This was thought to be due to poor position of the plate as well as too early weight bearing. In another case in which the fracture was fixed with a blade plate the fracture spread early but later became reduced and united as the blade slid up into the neck, allowing almost anatomic contour and length of the neck.

*Conservative versus surgical treatment.* Although there were no significant differences in age, sex, the type of general medical and nursing care, or general condition on admission between the patients treated conservatively and those treated surgically, the following factors were found to be significant in the end-results.

1. There was an over-all mortality rate of 25 per cent of 61 traced patients who had fractures treated by conservative means as compared to an over-all mortality rate of 8 per cent in 61 traced patients who had fractures that were treated surgically.

2. The amount of nursing care, general medical care and attention required of everyone concerned was much greater for those patients treated conservatively than for those treated surgically.

3. In 29 per cent of the traced patients that survived and were treated conservatively,



a b c

Fig. 9. a, An anteroposterior view of the left hip of a man, aged 51 years, showing a fracture, group 3. b, Anteroposterior view in the same case 2 months after operation, showing the fracture held by two vitallium wood screws. There was almost complete bony union of the fracture at this early date. The end-result was considered excellent. c, Lateral view of the same hip 2 months after operation.

complications developed during their convalescence as compared to only 23 per cent of those treated surgically.

4. The number of patients obtaining excellent or good results when treated conservatively totaled 60 per cent while there were 80 per cent excellent or good results in the surgically treated group. Only 24 per cent of the patients treated surgically had malunion of the fracture while in 54 per cent of those treated by nonsurgical methods this complication developed.

5. In only 1 of the 5 fatalities occurring in the surgical cases could the death be attributed to the operation itself. The remaining causes of death did not differ significantly from those of the 15 fatalities among the conservatively treated patient.

6. The average number of days in the hospital required for those patients treated surgically was 75 days as compared to 79 days for those treated nonsurgically. Although this difference may not be significant, most of the patients treated surgically could have gone home much earlier with less care being required than those patients in casts or traction.

Results of surgical and nonsurgical treatment are shown in Figures 1 through 9.

## CONCLUSIONS

1. The mortality rate for the treatment of intertrochanteric fractures of the femur may be considerably lessened by open reduction and the insertion of adequate internal fixation.

2. There is no one best method for securing adequate internal fixation, as the type of fixation used varies according to the type of fracture (degree of comminution and displacement) and the skill of the surgeon.

3. Our most preferred means of internal fixation is a blade plate, such as the Moore or Thornton, which has some curve or notch in the blade that prevents lateral cutting through the head and neck.

4. There is less morbidity and less care necessitated for the surgically treated than for the nonsurgically treated intertrochanteric fractures.

5. A greater number of patients obtain good or excellent results, after fractures of this type, when open reduction and internal fixation are employed than when nonsurgical treatment is used.

6. The number of days the patient is confined to the hospital should be materially reduced by surgical methods of treatment.

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# EXPERIENCE WITH THE OPERATIVE MANAGEMENT OF 280 STRICTURES OF THE BILE DUCTS

## With a Description of a New Method and a Complete Follow-up Study of the End Results in 229 of the Cases

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WITH almost no exceptions, injuries to the bile ducts occurring in the course of operations for gall stones are avoidable by following a few not too complicated rules which will be spoken of and illustrated later in this paper. When injuries to the bile ducts have taken place they present one of the most difficult surgical problems that confront the surgeon and one of the most difficult in which to obtain a satisfactory and lasting result. It is unfortunate that when the accident of a bile duct injury occurs, it is often in a patient who is otherwise well, usually not too advanced in years and who, were it not for the duct injury, would have the same prospect of length of life and good health as would a normal, well person.

When an injury to the bile ducts has occurred the prospect of life for the individual in whom it has occurred is definitely shortened and the prospect of the frequent appearance of undesirable complications, such as chills, fever, and jaundice, is rendered extremely probable.

In writing on this subject previously those of us in this clinic who have dealt with these strictures have stressed that duct injuries in the course of operations upon the gall bladder and bile ducts are the result of three types of accidents: hemorrhage from the cystic or hepatic arteries, confusion concerning the anatomy at the junction of the cystic, common, and hepatic ducts, or the presence of anomalous ducts or vessels causing uncertainty concerning the anatomical relationships between the ducts and the vessels in this region.

Cholelithiasis is a common disease, producing not infrequently symptoms of such urgent character as to make surgery the only means of relieving the patient.[1] Cholecystectomy has so properly superseded cholecystostomy as the operative procedure to be applied to the patient with gall stones that cholecystostomy has largely been abandoned, with the result that enormous numbers of cholecystectomies are being done every year all over the world. It is to be remembered that each time a cholecystectomy is done there is a real danger of injury to the bile ducts or hepatic artery, with the consequent possibility of producing in the patient concerned invalidism, shortening of life, or an operative fatality. It is for these reasons that we wish to discuss why such injuries occur, how they can be avoided, the various plans which we have employed and the changes we have made in dealing with patients who have strictures of the ducts, and to present a new technical concept (Fig. 15) concerning their management which was developed by R. B. Cattell and one of us (F.H.L.).

In the Lahey Clinic we have now operated upon 280 patients for stricture or destruction of the bile ducts. Some of these (41) have been of such recent date as to make their study not worth while. Therefore, of all cases done up to 1949, 239 have been studied. Ten patients could not be traced and so a complete follow-up study of 229 patients operated upon for duct destruction or stricture is presented. Each group is separated into the type of operation used; the results are reported as excellent, good, and unsatisfactory, and mortality rates are given.

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[1] In 1,029 patients operated upon for gall stones, 93.2 per cent complained of pain.

TYPES OF DUCT INJURY

For practical purposes, only two types of duct injury occur at the time of a surgical operation upon the gall bladder or bile ducts: crushing of the duct by grasping it with a clamp (Fig. 6) or the excision of part of the duct—common, common and hepatic, hepatic or sections of anomalous hepatic ducts. These two types of injury vary only in the level at which they occur between the point where the common bile duct disappears behind the duodenum and the point where the hepatic duct or ducts enter the liver. The portion of the common duct which passes through the head of the pancreas and behind the duodenum is so well protected here anatomically that it is rarely injured. It is by taking advantage of this point that the operative plan of repair which will be described and illustrated later in this paper (Fig. 15) has been developed.

Most of the crush injuries to the bile ducts are related to hemorrhages either from the cystic or the right hepatic artery and attempts to control such hemorrhage without clear visualization of the anatomical structures because they are obscured by the profuse hemorrhage at the depth of a deep cavity and because of the difficulty of keeping the blood sponged out so that the bleeding part can be clearly visualized and controlled.

In many of the patients upon whom we have operated for bile duct strictures, a review of the description of the original operation, a copy of which we have often obtained from the hospital where the original operation was done, has often revealed that serious bleeding was encountered and frequently controlled during the operation only by the application of a clamp which in several instances was left in place to be removed 3 or 4 days later.

If one will observe Figure 6, a and b, the explanation of the crush type of stricture is obvious. It will be seen that the right hepatic artery from which the cystic artery usually runs parallel with the hepatic duct which from above downward is just inferior to it and passes under or over the duct. It will be seen that the cystic artery, coming off as it normally does when not in an anomalous position, from the right hepatic artery, as it courses to the gall bladder across the angle made by the junction of the hepatic with the cystic duct, is shorter than the cystic duct. It will be noted in Figure 1, also, that if the gall bladder is removed from above downward, as it so frequently is in acute cholecystitis, and traction is then made upon the mobilized gall bladder, the traction will be almost entirely upon the cystic artery. With continued traction, the cystic artery will tear and not infrequently directly at its point of origin from the right hepatic artery. This will result in a vigorous type of bleeding since the hepatic artery or its right branch is of good size and can and does discharge a large amount of blood in a very short period of time. It is to be recalled, also, that this hemorrhage is in the depth of a deep wound and if there is not good exposure and good relaxation, there can be great difficulty in visualizing the point of origin of the hemorrhage and accurately controlling it.

Such an emergency can be avoided by careful dissection of the cystic artery before the cystic duct is clamped and cut, by taking great care not to make traction upon the mobilized gall bladder either when it is removed from above downward or by making traction on the ampulla of the gall bladder when it is removed from below upward. It has been a principle which has been religiously followed in this clinic that never must a cystic duct be clamped and cut until the cystic artery has been found and divided; the possibility of the occurrence of this type of hemorrhage by the undue traction on the artery may be thus avoided.

In Figures 2 and 3 is shown a safe method of dealing with cholecystectomy in acute and subacute gall bladders. It will be noted in Figure 2 that the index finger has been inserted through the mesentery made by the edematous tissue between the cystic duct, the hepatic duct and above the cystic artery as it comes off the right branch of the hepatic artery. By inserting one's finger gently through this edematous mesenteric region close to the bed of the liver, a line of cleavage can be definitely established between the gall bladder and the fibrous bed of the gall bladder in the liver. In Figure 3 is shown the continuation of the separation of the line of cleavage

between the edematous gall bladder and the bed of the liver as the finger is carried upward toward the edge of the liver. This has proved a very safe and rapid way of removing the subacute gall bladder. It is important, however, in performing this procedure to be certain that the finger as it is inserted through the edematous mesentery is close to the bed of the liver and does not tear the cystic artery as it comes off the right branch of the hepatic artery. This accident will occur if the finger is inserted through this edematous membrane too close to the point of entrance of the cystic duct into the common and hepatic ducts. In the inset in Figure 3 is shown the ability in the acute and subacute gall bladder, by turning the gall bladder toward the left, to visualize the anatomy and to wipe out the cystic artery, the hepatic duct, the cystic duct and, in many cases, the arching right hepatic artery. This has proved a safe and valuable method to deal with cholecystectomies for acute and subacute gall bladders and one which by tipping the gall bladder to the left after it has been freed from the bed of the liver, has made the anatomical exposure of the structures, even when the tissues are edematous and indurated, much safer than if an attempt were made to do this operation from below upward.

In Figure 4 is shown the well known procedure which makes the management of hemorrhage of the cystic or right hepatic artery relatively simple should accidental injury to these vessels occur, as will be inevitable in occasional cases. It is to be noted that if such a hemorrhage occurs, one may introduce the index finger into the foramen of Winslow, the thumb then palpates the hepatic artery just above the common duct and it is compressed between the thumb and finger. This compression controls bleeding, the clot may be wiped out, the field may then be well exposed by wide retraction, the thumb can be released, the bleeding permitted to occur momentarily, the field again wiped dry, and thus the bleeding point accurately picked up without injury either to the hepatic artery if the hemorrhage is from the cystic artery, or to the underlying right branch of the hepatic artery. The vessel can then be accurately tied with silk and the situation has then been completely controlled

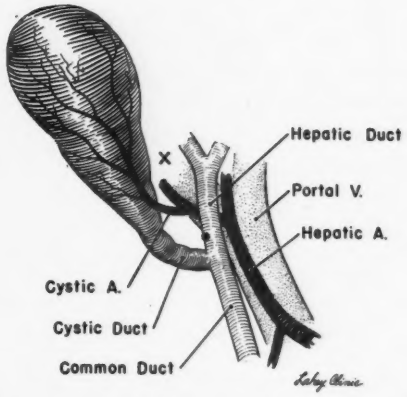


Fig. 1. Note in this illustration when hemorrhage from the cystic artery has occurred how easily the common hepatic duct may be caught when a clamp is put on blindly. Note the point marked *X* through which the finger is inserted in the method of removing the gall bladder in the presence of acute cholecystitis. (See Figs. 2 and 3.) Note also the danger to the cystic artery if the finger is inserted too low in the mesentery of the gall bladder.

without injury to the duct. That when the right hepatic artery is ligated partial atrophy of the right lobe of the liver occurs together with compensatory hypertrophy of the left lobe was suggested by such an occurrence in a recent case in which such an accident had taken place and these conditions could be demonstrated when an operation for duct repair was being done.

A much less common type of duct injury is that in which an entire section of common and hepatic duct is cut away as the result of so lifting upon the gall bladder that a clamp supposedly applied to the cystic duct is applied to the angulated or peaked common and hepatic ducts.

Other injuries than these are most commonly the result of the occurrence of anomalous anatomical arrangements, such as double right hepatic ducts, cystic ducts entering the right hepatic duct and cystic ducts passing beneath the duodenum and entering the common duct at some point behind the duodenum and anomalous arterial supply to the liver and gall bladder. All of the accidents of this character can be avoided by wide exposure, dry field, good light, and such accurate anatomical demonstration of the bile passages,

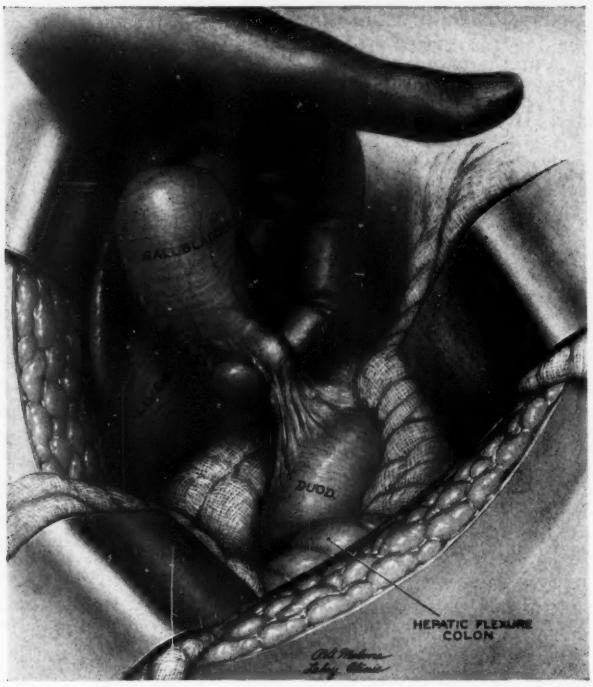


Fig. 2. In this illustration is shown the method of inserting the finger through the mesentery of the gall bladder in cholecystectomy for acute and subacute cholecystitis. Note that the finger is inserted close to the liver to avoid the cystic artery, as shown in Figure 1.

common, cystic and hepatic ducts, hepatic artery, and cystic artery that any anomalies are clearly recognized.

In previously writing upon this subject one of us (F.H.L., 6) laid down a simple set of rules which, if followed, will avoid the occurrence of any and all of the aforementioned accidents. They consist of good relaxation, best accomplished by means of spinal anesthesia or the use of curare with a general anesthetic agent, and long incisions in order to obtain adequate exposure. When one balances the dangers and hazards of inadequate exposure and the possibilities of the production of these sometimes fatal and often crippling complications against 3 or 4 extra inches of an abdominal incision, the side on which advantage rests is at once obvious.

In addition to adequate relaxation and long incision, we wish again to call attention to the plan which we have previously described of obtaining exposure of these important anatomical structures—the common duct, the hepatic duct, the cystic duct, the hepatic artery and the cystic artery (Fig. 5). Exposure of these structures can be obtained most satisfactorily by mobilization of the hepatic flexure and the duodenum to the left and by retraction of the liver to the right. It is to be recalled anatomically that the normal position of the common and hepatic ducts is a lax one, that normally, owing to the laxity of the common and hepatic ducts, the aperture into the lesser peritoneal cavity at the foramen of Winslow does not gape but is collapsed. With the duodenum and the hepatic flexure retracted to the left and the liver to the right, it is possible as shown in Figure 5, so to put the hepatic duct and the common duct upon the stretch that the opening into the lesser peritoneal cavity at

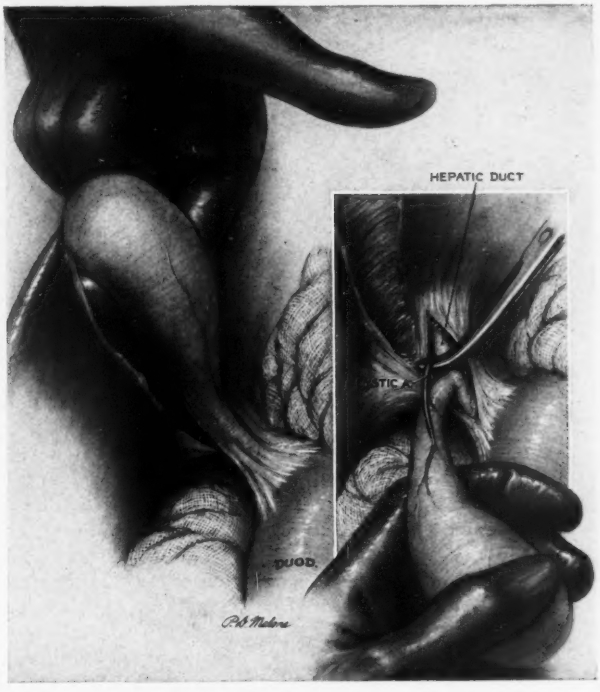


Fig. 3. In this illustration is shown how readily the finger passes behind the gall bladder in the layer between the gall-bladder wall and the fascia layer over the liver. In the inset is shown the method of turning the gall bladder to the left and the ability with this exposure to demonstrate the common duct, hepatic duct, cystic duct and the cystic artery, which may be clamped before removal.

the foramen of Winslow gapes widely and is made completely visible, so visible that in these patients the vena cava on its posterior aspect becomes clearly demonstrable. With this type of retraction and exposure, the duct structures which must be dealt with, together with the cystic artery and hepatic arteries, can be plainly seen even in fat individuals. All anatomy can be demonstrated, the cystic artery can be found and clamped under clear and direct vision, and the point of junction of the cystic duct with the common and hepatic ducts clearly demonstrated. Not only does this exposure make it possible to deal with these structures, cystic duct, common duct, hepatic duct and cystic artery, with safety but, in addition, the anatomy is so plainly visualized at this point of junction of the cystic duct with the common and hepatic ducts that accessory bile ducts can frequently be plainly recognized, clamped and tied, thus avoiding the discharge of bile which frequently occurs after operation when gall bladders are removed without this exposure and unrecognized accessory ducts are torn away.

Without these exposures we would never have felt justified in making so many investigations of common ducts, 44 per cent, in patients having cholecystectomy as we have over the years; without such exposure we would have faced the risk of producing duct injuries, such as strictures and biliary fistulas.

The history associated with these injuries is usually related to the type of injury. In those patients in whom there is uncontrollable bleeding from the cystic artery or hepatic artery

Fig. 4. In this illustration is shown the method of controlling bleeding from the cystic artery, shown by the arrow, by means of putting the index finger in the foramen of Winslow and the thumb over the hepatic artery.

and in whom the hepatic duct has been crushed by a clamp applied to control bleeding, the appearance of obstructive biliary symptoms is delayed. In the cases in which the clamp, as is often the case, has been put on blindly deep in the field in a last desperate attempt to control bleeding, there is frequently no discharge of bile or jaundice following the removal of the clamp at the end of 4 to 5 days because, upon removal of the clamp, the crushed duct expands and does not immediately produce an obstruction. It is in these cases that, as a result of the crush, narrowing of the duct as a result of fibrosis takes place usually 3 to 4 months after the injury, with recurring attacks of jaundice, chills, and fever at that delayed time and not immediately after the injury.

When there has been such an accident and when, 3 to 4 months after the patient has left the hospital, there is a history of recurring attacks of jaundice, chills and fever, or even jaundice alone, one should be suspicious that this condition is the result of fibrotic narrowing of the duct at the point where the crush occurred.

In other cases, particularly those in which sections of the duct have been taken out or anomalous ducts have been cut, there will be immediate discharge of bile following the operation and the continued discharge of bile for an indefinite period.

An event which has occurred in almost all of our cases of this type is that after a considerable period of time the external biliary fistula closes spontaneously, the patient becomes jaundiced and the stools acholic. Shortly after this the jaundice spontaneously disappears, the stools become normally colored and the patient feels well. This represents the occurrence of a spontaneous internal biliary fistula due to the rupture of the dilated hepatic duct into the adjacent duodenum to which it usually becomes adherent. There may be rare cases in which this spontaneous fistula remains permanently patent but such has not been the case in dealing with those 280 patients with strictures of the duct upon whom we have operated. In practically every case in which we have attempted these bile duct repairs a fistula into the duodenum has been found but by the time the patient has come to us for duct repair the fistula has in nearly every case so contracted down that almost no bile is passing through it.

In a patient who has had an injury to the bile duct and in whom repair has been attempted, complete and uninterrupted successful restoration of bile flow into the intestine is to be assumed only when the external biliary fistula closes completely and the patient remains free for over a year from the appearance and persistence of jaundice or the occurrence of skin itching, increased bilirubin, chills and fever.

The prospect of a good surgical result in all operations for the repair of injuries to the bile ducts will depend upon which type of injury (crush or excision) to the bile duct has taken place, whether or not previous attempts have been made to repair the resulting stricture, how soon after the injury the repair of the duct is attempted, and whether or not, as the result of long delay and repeated failures to repair the stricture successfully, cirrhosis has resulted because of irreparable liver damage from the biliary obstruction and repeated attacks of biliary infection so frequently associated with these failures.

The best results in operations for repair of the bile ducts will be obtained in those patients with crush injuries of the duct and with the remaining portions of the ducts intact. Most

Fig. 5. In this illustration is shown the method which we have previously described of obtaining exposure of the region of the common and hepatic ducts in patients who have had several previous operations upon their gall bladder. Note that the hepatic flexure has been mobilized from the lower edge of the liver and rotated to the left until the duodenum, usually adherent to the hilum of the liver at the point where previous surgery has been done upon the ducts, is visualized. The duodenum can now be so mobilized that all of the duct structures can be brought out.

of these injuries will result in but short strictures of the duct as shown in Figure 6, and because of the short section of the duct injured, will lend themselves to plastic repair (Heineke-Mikulicz type) as illustrated in Figure 6 (end-results—100 per cent good—in this type of repair are given in Table VIII) or to excision of the strictured area, mobilization of the lower end of the common duct from its place behind the duodenum in the head of the pancreas, as practiced in this new concept of duct repair later to be described, and accurate mucosa-to-mucosa suture of the ducts by end-to-end anastomosis, shown in Figure 15.

The next best results will be obtained in those cases in which short portions of the duct have been accidentally excised in the course of the cholecystectomy in which it has been possible to undertake the repair by end-to-end anastomosis within a few days of the time of injury and in which no previous attempt to repair the injury has been made.

The poorest results will be obtained in those cases in which several unsuccessful attempts have already been made to repair the injured duct.

If we have learned anything from this large experience with operations for the repair of bile duct injuries it is that every time an unsuccessful attempt is made to repair an injured bile duct there will be loss of duct structures and most frequently and unfortunately loss of

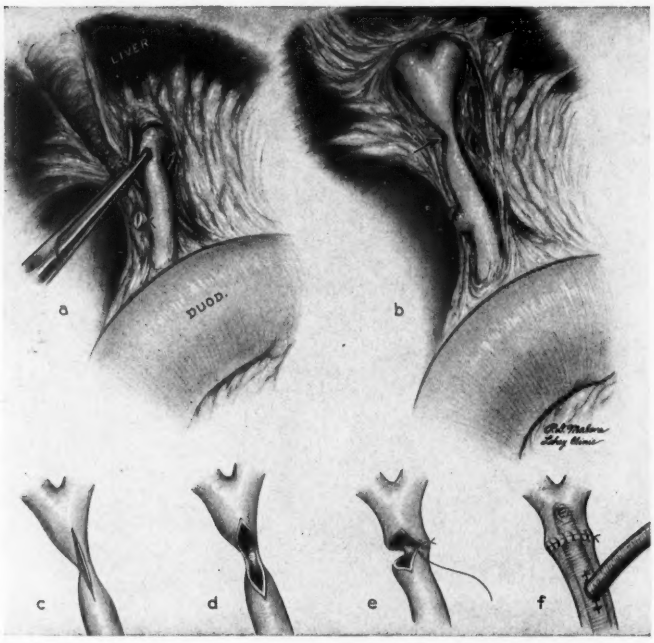


Fig. 6. This illustration demonstrates how the crush type of injury to the hepatic duct occurs. Note in a, the diagrammatic illustration of a clamp grasping the cystic artery, the right branch of the hepatic artery and at the tip including the hepatic duct. In b, note the short and local stricture which results from this type of injury. In c, d, and e, the Heineke-Mikulicz type of repair. Note in f, the principle which Lahey has described of placing the T tube through a separate incision in order that it does not have to be withdrawn through the suture line.

hepatic duct structure, and as the result of this, greater and greater difficulty in fulfilling the fundamental requirement of our concept of the most successful way to repair duct strictures or defects, that is, mobilizing the lower end of the common duct from the head of the pancreas, suturing the ends of the mobilized ducts accurately together by mucosa-to-mucosa end-to-end anastomosis, and leaving for a period of up to 1 year an indwelling T tube placed below or above the suture line to support the suture and insure patency. The leaving in for a year of one limb of a supporting T tube through the suture line of the anastomosed duct and introduced through an incision in the duct either above or below the line of anastomosis as proposed by Lahey is an extremely important step in this operating plan since in many of these cases the ducts are scarred, the suture difficult, and the anastomosis at times not as meticulously accurate as one could want it to be.

Following repeated unsuccessful previous reparative operations upon the bile ducts, as has been true in many of the cases coming to us for repair, the only portion of the hepatic ducts which frequently remain intact in such patients will be the two limbs of the hepatic duct which are intrahepatic (Fig. 7). All too often following these repeated attempts elsewhere at bile duct repairs we have found in our attempts to accomplish repair in them that all of the extrahepatic duct which then remains as a single duct structure will have been destroyed. The hepatic duct portion of the biliary duct tract will then be represented only by the separated two main intrahepatic divisions of the hepatic ducts, to which end-to-

end anastomosis of the mobilized single common duct is impossible. It is to be recalled that the ingenious operation devised by Longmire of anastomosis of the left lobe of the liver and left bile duct in it to the jejunum will not be ideally applicable here since, with no common hepatic duct, there will be no communication between the right and left lobes of the liver. It is in these cases that the only procedure left to employ is a "Y" tube made of plastic material called bouncing clay and with the Y ends of the tube introduced into the hepatic ducts and into the mobilized end of the common or hepatic duct or into the jejunum or duodenum or the use of a T tube with a Y end as shown in Figure 8.

Recently, Cattell (Fig. 7) of this clinic has devised an ingenious plan of repair of cases of this type. Following his suggestion Lahey also made use of this plan in one of the cases in which there was no common hepatic duct and only the two separated intrahepatic ducts entirely within the liver, and found it of great aid in managing these difficult cases.

After dissecting the intrahepatic ducts out of the substance of the hilum of the liver with the fulgurating loop and with blunt scissors, the two ducts are brought together by catgut sutures and the two attached walls cut to convert them into a single common canal. One of the limbs of a T tube is then cut, as shown in Figure 7, and one limb placed up one duct, the other up the other hepatic duct after the T tube has been placed in the common duct which has been mobilized and brought up for suture to the end of the two hepatic ducts now made into one.

Lahey has recently devised a tube (Fig. 9) for introduction into the intrahepatic ducts and with the long limb passing down the anastomosed common duct as shown in Figure 10.

We have operated upon many patients with injuries and strictures of the bile ducts after they have had three, four, five, and recently one with seven and one with eight previous attempts at repair, and we feel safe in saying that with each unsuccessful attempt at duct repair the changes for a satisfactory and lasting outcome progressively diminish. Lest surgeons dealing with this type of operation be unduly intimidated by cases in which have been made several unsuccessful attempts at repair, we would state one of our most successful results following the use of the new plan here suggested was in a patient who had had seven unsuccessful attempts at repair before coming to us.

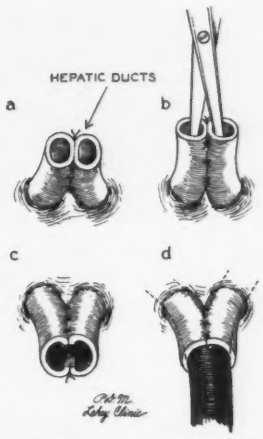


Fig. 7. In this illustration may be seen the complete loss of the common hepatic duct with only, as shown in a, the two separate right and left hepatic ducts. This illustrates the plan devised by Cattell, of this clinic, of converting the right and left hepatic ducts into one common hepatic duct and the introduction of a Y tube into them for anastomosis of the common duct to them.

In an editorial (5) on this subject published in SURGERY, GYNECOLOGY AND OBSTETRICS, Lahey, with great reluctance lest it be misunderstood, urged that everyone undertaking repair of an injured duct should realize that whoever undertakes the first duct repair will have the best chance to obtain a lasting and satisfactory result, that with each failure the chances of a successful outcome are markedly diminished. The operative procedure which offers real hope of lasting and successful results and the one based upon logical surgical principles is mobilization of the lower end of the common duct and head of the pancreas so that accurate end-to-end anastomosis can be done. It is with these facts in mind that we suggested that one should seriously review his ability, equipment, and experience before undertaking repair of these injuries lest repair be made hopeless for the surgeon experienced with such cases when they are finally placed in his hands.

Fig. 8. Roentgenogram of such a case in which a direct anastomosis of a mobilized common duct to two hepatic ducts which have been converted into one by the procedure devised by Cattell.

Again, that readers of this paper may not despair completely about these at times seemingly hopeless cases, we cite brief notes concerning 3 patients whose condition appeared quite hopeless but who have obtained quite satisfactory results, despite many previous operations.

CASE 1. A 34 year old golf professional was first seen at the clinic on June 29, 1943, with the following previous history. In 1933 a cholecystectomy and appendectomy were performed elsewhere for jaundice. The gall bladder was found to be negative for stones. Following operation he had been quite constantly jaundiced and the jaundice had deepened. On December 7, 1942, a stricture of the common duct was repaired elsewhere; a T tube was implanted and remained in place for 3½ months. After its removal the jaundice and itching recurred.

When he came to the clinic a diagnosis of an incomplete stricture of the bile duct was made and he was admitted to the hospital on June 30, 1943. He was given preoperative care for 1 week and then submitted to surgery on July 7, 1943. A stricture was found 4 inches proximal to the ampulla located at the hilum of the liver. The stricture was dilated to 7 millimeters and a T tube was inserted beyond the strictured portion with one limb of the T tube passing through the stricture. His postoperative course was uneventful.

Because the jaundice did not disappear the patient was submitted to intensive study after which a diagnosis of congenital hemolytic anemia was made which was probably the cause of the jaundice for which he had his only operation. With the T tube still in place, on December 14, 1943, a splenectomy was performed. During this same hospital admission a second operation was performed on the common duct, at which time a plastic repair of the common and hepatic ducts with the insertion of a straight vitallium tube was performed (Fig. 11). This was done because the T tube had become obstructed by bile and stones. Following these operations his jaundice cleared completely for a brief period.

His next visit to the clinic was in August, 1945, at which time he stated that from shortly after his last operation he had never been free of intermittent attacks of jaundice, with clay-colored stools. It was decided that his vitallium tube had become obstructed. On August 27, 1945, operation on the ducts was again performed, at which time the vitallium tube, which was obstructed with débris, was removed. A biliary fistula was noted between the bile duct and the duodenum. The vitallium tube was replaced by a T tube with the long arm extending through the ampulla to the duodenum and the proximal arm above the stricture. A postoperative hemorrhage occurred and on September 3, 1945, he was returned to the operating room, at which time a branch of the gastroduodenal artery was ligated. This tube was left in place until October 15, 1945, and then removed by merely pulling on the external portion of the T tube.

The patient was next seen at the clinic in October, 1946, at which time he was playing golf and only occasionally had pruritus. In June, 1947, he reported that he was having no pain, fever or chills, that he was well and on a rigid liver regimen. He reported again in October, 1947, after a mild attack of cholangitis. A letter was received February 23, 1949, at which time he was enjoying good health.

In summary, this patient had had 7 surgical procedures of which 5 were on the biliary tract, 4 of which were for the repair of a stricture of the bile duct. In addition, he had had a splenectomy for a coincidental hemolytic anemia which, in all probability was the cause of his original jaundice for which the original cholecystectomy had been done, and a final operation for intra-abdominal hemorrhage. This patient was reported recently to be quite well.

CASE 2. This patient had had a cholecystectomy in October, 1943, with an injury to her bile duct. She

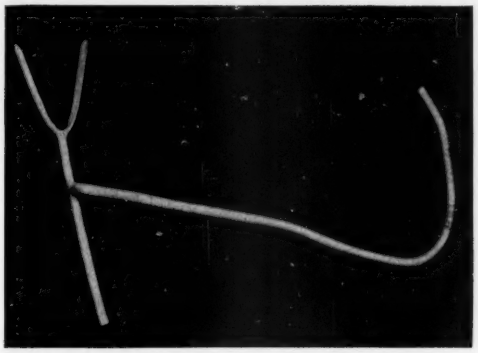

Fig. 9. Note in this illustration the T tube devised by Lahey, the two limbs of which going into the right and left hepatic ducts are half caliber tubes so that they can be readily passed through the short stump of common hepatic duct marked *X* in Figure 10. It will be obvious in dealing with this type of duct injury that it would be impossible to pass a Y tube through the stump of the common hepatic duct marked *X-2* if the tubes were of full caliber but when they are of half caliber, when brought in approximation, they represent only the caliber of a single tube and can then be passed through the common duct marked *X-2* and each then guided into the left and right hepatic ducts.

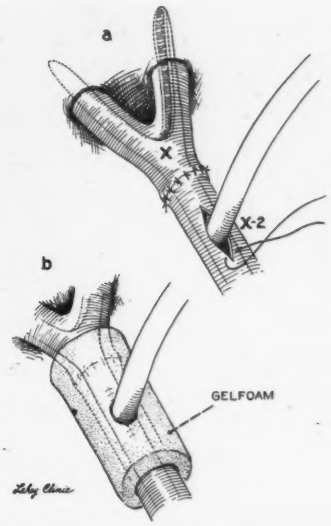


Fig. 10. a, In this illustration is shown the method of doing a direct end-to-end anastomosis of the common duct to a short stump of hepatic duct and the use of the tube devised by Lahey and shown in Figure 9. In b, is shown diagrammatically the method of wrapping the anastomosis up in gelfoam to discourage bile leakage. Note again the method of introducing the Y tube through a separate incision in the common duct (*X-2*) so that a complete circular anastomosis can be made and with no tube emerging through the suture line.

had had two previous repairs of her common duct elsewhere in 1943 and 1944. During the latter part of 1944 a T tube was inserted, elsewhere, into the hepatic duct and the common duct. She managed to get along with the T tube until 1947, when she again became jaundiced and was operated on again, with the insertion of another T tube. This T tube pulled its external part into the ducts and passed itself down the common duct and into the duodenum in 3 months. In January, 1948, another T tube was inserted elsewhere, but in spite of this, it became blocked and the patient came to us for repair of her duct. (There had thus been 6 previous operations on the biliary tract before the patient came to the clinic and 7 previous operations on the gall bladder and ducts.)

On July 14, 1948, operation was performed. The common hepatic duct was found with almost no cuff remaining—that is, almost all the common hepatic duct had been destroyed—and a Y tube was inserted into the two limbs of the hepatic duct with less than 1 centimeter of hepatic duct remaining. To this the mobilized common duct, which was freed from the pancreas and from behind the duodenum, was anastomosed directly to the short cuff of remaining hepatic duct over a completely indwelling Y tube of bouncing clay, with complete and satisfactory restoration of flow of bile into the intestinal tract (Fig. 12).

This experience demonstrates how complicated these cases can be and yet how possible it is in many of them to re-establish the bile flow in spite of many (in this case, 6) previous operations elsewhere upon the biliary tract. This patient reported that on September 15, 1949, she had one mild attack of jaundice but otherwise has remained completely well.

CASE 3. This case likewise illustrates how complicated and seemingly hopeless these cases may be. The patient had had a cholecystectomy elsewhere in 1947, at which time, either as a result of the acute gall-bladder condition for which the cholecystectomy was done or because of injury to the duct, a stricture resulted. Within the same year she was operated on again elsewhere, and an anastomosis of the hepatic duct to the duodenum was done. This failed to function, and a further operation was done elsewhere, again anastomosing the hepatic duct to the duodenum.

When this patient came to the clinic she was deeply jaundiced; she had had chills and fever for 2 months and had a large liver.

The hepatic duct was found with but a very short proximal stump remaining. Its end was anastomosed over a Y tube of bouncing clay to the common duct mobilized from the pancreas and from behind the duodenum (Fig. 8). After this anastomosis the

Fig. 11. A vitallium tube is shown in place. Note the projecting tab and recall that in spite of this projecting tab some of these tubes have passed spontaneously through the common duct into the duodenum.

patient became jaundiced, and a subdiaphragmatic abscess developed, which required drainage, but the jaundice failed to clear. She was sent home to die, with the idea that no more could be done. A further accumulation of the subdiaphragmatic abscess ruptured through the bronchus, and bile was discharged through the bronchus. A communication from her physician reported that it did not seem possible that she could recover.

Recent examination of this patient indicates that the bronchial fistula has closed, bile is now draining into the intestinal tract, jaundice has cleared, and the patient appears to be at least temporarily recovering.

Last note: This patient returned to the clinic October 17, 1949, for check-up examination. Except for occasional expectoration of bile in large quantities she had been remarkably well. After examination at the clinic it was concluded that she had a biliary bronchial fistula which drained intermittently when the normal bile passages were partially obstructed and, therefore, acted as a safety valve. While she was in the hospital the expectoration of bile decreased. No jaundice was noted. Because of her relatively satisfactory condition and because we feared the effect of closing the mediastinal fistula, medical management was advised. The patient was discharged October 28, 1949.

These operations have been most complicated and trying ones. They have often exhausted our resources in surgical ingenuity in our attempts to deal with them and they have frequently disappointed us in their outcome. On the other hand, we have had to approach these cases with our minds made up that many of them are truly desperate problems demanding desperate measures, and that in many of them nearly all measures had been exhausted before the patients came to us for a last trial of surgical repair before accepting the otherwise inevitably fatal outcome which must follow. We wish, however, again for the benefit of patients who have these injured bile ducts and for the benefit of surgeons who are interested in accumulating experience in repairing them to direct attention to the tables in the latter half of this paper which present follow-up results, and to state that, considering the character of the lesion dealt with, these are far from discouraging follow-up figures.

We would like to list and illustrate in the sequential order in which we have employed them the different operative plans we have used over the years in dealing with patients who have bile duct injuries, and to comment upon and draw some general conclusions from them.

In 1930 one of us (3) became interested in bile duct strictures and published his experiences in transplanting complete external biliary fistulas into the jejunum in 14 cases in which the bile duct had been cut off before the patient came to him. In those cases, as shown in Figure 13, the external biliary fistula was preserved by coring it out of the abdominal wall in such a manner as to conserve its walls so that, with a small rubber tube inserted into the end of the fistula to prevent its collapsing, it could be implanted into the jejunum and held there by pursestring suture.

As we now know from this good-sized experience with patients who have had bile duct injuries, and many of whom had external biliary fistulas, this plan of surgical procedure was unsound in principle (only 2 have remained well). In almost all of these patients the transplanted fistulous tract closed because of two things. One was that in many of these cases spontaneous internal biliary fistulas de-

veloped as a result of rupture of the fistulous tract, most commonly into the duodenum, when that structure became adherent to the fistulous tract, as it sooner or later does in practically all of such cases. Such adherence results in the lowering of the secretory pressure of bile within the transplanted fistulous tract and the eventual contraction and closure of the transplanted fistulous tract and later, in addition, closure of the spontaneous internal biliary fistula. It has been our experience in operating upon these 280 patients with strictures of the bile duct that in almost every case in which we have operated either a small internal biliary fistula was found which was inadequate in size to drain the bile into the duodenum or there were evidences of the previous existence of one which had closed by the time repair of the strictured duct was undertaken. The other factor causing this fistula transplant operation to be unsuccessful is the fact, which must have been demonstrated to everyone now many times in patients with external biliary fistulas, that the general tendency of a complete external biliary fistula is to close. This fact indicates that the contractility of the scar tissue making up the wall of these fistulas will in practically all cases be greater than the secretory pressure of bile, the only thing which keeps these fistulas open, thus resulting in ultimate closure of the fistulous tract, whether it be external or internal.

While there may be occasional cases in which spontaneous internal biliary fistulas and those which have been implanted into the duodenum or jejunum will remain open, in most of these cases spontaneous closure of these fistulas will occur, and this operation has properly been abandoned. This is in agreement with the general principle which applies to all types of re-establishment of bile flow into the intestine, that is that it will be successful only when mucosa-to-mucosa union of bile ducts is accomplished.

One of the earliest operations to be employed in attempts to restore the bile to the intestinal tract in patients whose bile ducts had been severed or destroyed was the one popularized several years ago by W. J. Mayo, the mucosa-to-mucosa anastomosis of the cut end of the hepatic duct to the duodenum or jejunum, choledochoduodenostomy or choledochojejunostomy, or hepaticoenterostomy.

When accurate mucosa-to-mucosa suture is made of the cut end of a severed and dilated hepatic duct to the duodenum or jejunum, reinforced by outside sutures to insure the security of the anastomosis (Fig. 14), the communication between the duct and the intestine when it is adequately large will remain permanently patent in most of the cases. This is a very useful and effective surgical procedure. Its drawback is that with no sphincter between the liver and the intestinal tract there will be in many of the cases regurgitation of intestinal contents of the duodenum or jejunum up into the biliary tree, with frequent chills, jaundice, and fever as the result of the cholangitis brought about by this regurgitation.

Although numerous suggestions, such as lateral anastomoses between the two limbs of the loop of jejunum into which the fistula has been transplanted, enfolding of the loops or the use of single segregated loops, have been employed to improve this procedure, it can be said with certainty that to maintain protection of the liver from ascending infections after duct repairs there is, when the operation is possible, no substitute for preservation of the sphincter of Oddi.

This operation of biliary intestinal anastomosis is one which will not infrequently have to be employed when the caliber of the common duct which has been mobilized from the head of the pancreas is so small, atrophied, and fibrosed from disuse that it will not be possible to dilate the end used for the anastomosis to the distal end of the hepatic duct. Attempts to dilate fibrosed and atrophic common ducts recovered from the head of the pancreas have resulted in most of the cases in splitting the common duct and spoiling it. In other cases, due to the scarring and fibrosis as the result of previous attempts at repair, it will not be possible to find the lower end of the common duct and employ the plan which we have described in this article, mobilization of the common duct from the head of the pancreas and direct end-to-end anastomosis of the ducts. It has been our experience that the number of cases in which the lower end of the cut duct cannot be found in the head of the

Fig. 12. In this illustration is shown diagrammatically the type of lesion dealt with in illustrative Case 2. Note again in this case the relatively short common hepatic duct and the employment of a Y tube of bouncing clay over which the anastomosis has been made. Note also in this the diagrammatic illustration of the splitting of the head of the pancreas and rotation of the duodenum to find the uninjured portion of the common duct behind the duodenum and in the head of the pancreas.

pancreas will progressively diminish as one's experience with finding it increases.

It is, therefore, of interest and encouragement to call attention to Table X in the follow-up portion of this paper in which satisfactory results were obtained in 73.1 per cent of the patients treated by this method.

When restoration of the bile ducts can be so accomplished as it often can by freeing the lower end of the common duct from the pancreas and by mobilization of the duodenum and end-to-end anastomosis of the ducts, as will be later discussed, so that bile flows without obstruction along the main bile ducts into the duodenum and when the bile passages are protected against ascending infection by the preservation of the normal sphincter of Oddi, the most ideal surgical repair of an injured bile duct has been accomplished (Figs. 12, 15 and 16).

The next step in the sequence of our attempts to repair injuries to the bile ducts was that of employing, as a substitute for the duct defect, tubes of various types of material, rubber, vitallium and last in sequence of appearance, a material called bouncing clay (silicon) to bridge defects in the injured ducts. These attempts to bridge defects by tube implantation were made before we developed the plan of mobilizing common ducts from the

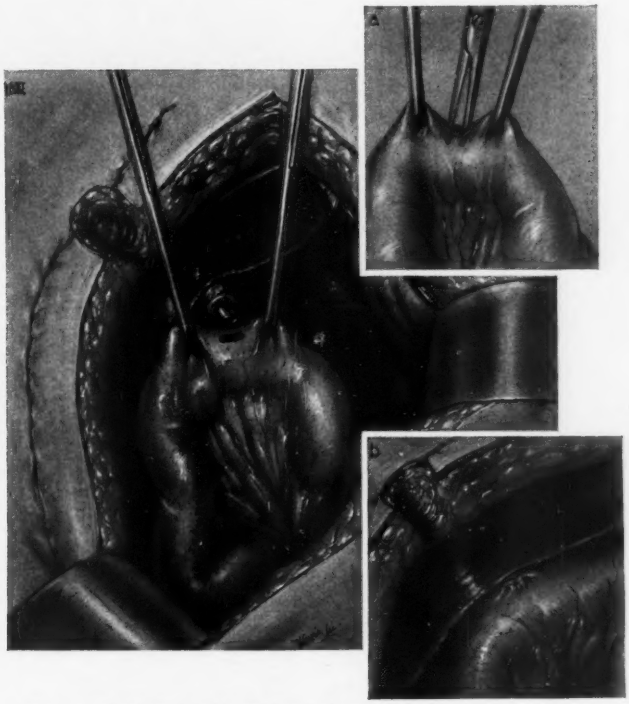

Fig. 13. In this illustration is shown the method of coring an external biliary fistula from the abdominal wall and implanting it into the jejunum. Note in the main illustration the introduction of a small segment of rubber tube to prevent collapse of the fistula. In inset a, is shown the method of producing a small opening into the jejunum into which the fistulous tract can be implanted and in inset b, the fistula is inserted into the jejunum, surrounded by a silk pursestring stitch and approximated to the under edge of the liver. This method of treating strictures of the bile duct has been completely abandoned now for a good many years and the method is shown only to condemn it.

head of the pancreas and direct end-to-end anastomosis of the ducts. This silicon material, like rubber, is capable of bouncing and stretching, and is so flexible that it will readily adjust itself to the tortuous angulations of the fistulous tracts into which these tubes must be implanted when they are used, as they often are, as makeshift procedures when other more ideal plans are not feasible.

In our attempts to bridge defects in injured ducts we have employed implantations into the bile ducts of tubes of one of these types of material in the past 10 times, from 1940 to 1948, with only 20 per cent satisfactory outcome (Table XI). While these tubes have successfully bridged the defects made by loss of varying sections of the duct and have remained patent varying lengths of time, the general tendency of such implanted tubes has been to become plugged in from 1 to 2 years by the crystalline elements of the bile passing through them and likewise the general tendency has been for the defect segments to stricture again when the tube has passed as it has in many of the cases in spite of all measures to retain it in place.

Some of our experiences with the implantations of these tubes will be of interest and may be of value to others who have to deal, or may have to deal, with strictures of the bile ducts

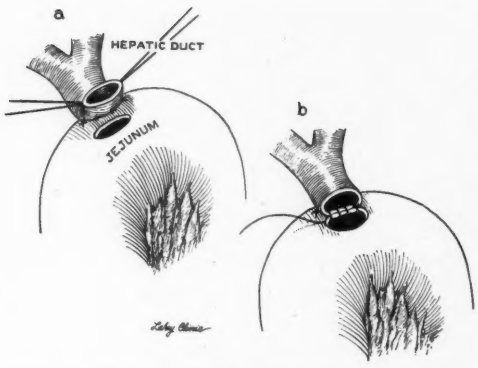


Fig. 14. Diagrammatic illustration showing the double suture line of hepaticojejunostomy when possible, and it is not always possible, to employ two suture lines, the outside one of silk and the inside one of accurate mucosa-to-mucosa anastomosis. This is the safest method and in the hepatic duct with a large lumen there is then the best assurance of permanency of patency.

of such complicated character that it may not be possible to employ the ideal plan we wish to describe.

Case 1, reported earlier in this paper, is of interest in connection with these types of duct injuries in that 7 operations were done upon this patient's bile ducts. Three tubes were implanted in the ducts, each of which plugged and required removal. The last tube was removed without introducing another tube and the patient has now gone almost 5 years without biliary obstruction. It is to be realized, however, that in both of these cases the sphincter of Oddi remained intact to protect the liver from the effects of ascending infections of the biliary tract.

We have implanted vitallium tubes 46 times in patients with strictures of the bile ducts. So much which is unintentionally misleading has been written and said about the use of vitallium tubes in strictures of the bile ducts that we wish to discuss the employment of these tubes following our experience with them. In discussions of papers on this subject at surgical societies, Lahey has stated that we believe the original plan of the employment of tubes made of vitallium was wrong in its conception. Vitallium tubes were suggested as a means of bridging gaps of duct defects following duct injuries largely because vitallium, first proposed by Charles Venable, is a non-electrolytic metal and is so well tolerated by the tissues elsewhere, as with screws, bone plates, hip cups, skull defects and so forth. This tissue tolerance feature of vitallium tubes is of little significance in the repair of strictures of the bile ducts since there has never been any problem of tissue tolerance in the implanting of any of the tubes, rubber, vitallium or bouncing clay. All three materials have been equally well tolerated by the tissues. The real problem which concerns us in the use of tubes of any material is, is there less likelihood of plugging in one tube as compared with the other? There appears, from our experience, to be little difference in tubes of any of these three materials in their tendency to plug with inspissated bile.

There are no advantages in the use of implanted vitallium tubes over rubber or bouncing clay tubes and there is at times a real disadvantage in their use in that they are rigid and inflexible. Because of this, in certain cases they are very difficult to introduce since they do not adjust themselves to the angulations sometimes found in the bile tracts encountered during attempts to repair strictures or duct defects where previously unsuccessful reparative operations have preceded the repair being made.

It has been our experience also that these tubes, in spite of the tab attached to them, as shown in Figure 17, can and have been passed, tab and all, into the duodenum through the sphincter of Oddi even when they have been anchored by a silk stitch through the hole in the tab attached to the tube. One would hardly imagine that such a metal tube as shown in Figure 17, with such a metal tab attached at right angles to the tube and sutured in by a silk stitch, could pass through the junction of the common duct with the duodenum without producing real damage but, as stated, such has been our experience with them. In addition, serious complications have been reported by others as the result of the passage of these tubes into the duodenum. To demonstrate this inclination of tubes placed within the ducts to pass into the duodenum, we would like to call attention to Case 2 in the 3 cases reported in this paper in which a successful

repair was done. In this case 1 of the 6 previous attempts at repair before coming to us consisted of the introduction of a T tube into the strictured duct with one end of the T tube passing through the stricture, only to have the entire T tube, including its external limb, spontaneously pull into the common duct and the entire T tube to be passed into the duodenum, and be discharged in the feces.

While we have never employed these vitallium tubes as a method of connecting a cut hepatic duct directly to the duodenum when the lower end of the common duct has not been found, this has been reported by others a sufficient number of times, with hemorrhage, perforation and death as the result of pressure from the tube within the duodenum to make this, we believe, an unwise procedure.

Bouncing clay (silicon) tubes have the advantage over tubes of other material only in that they can be readily cast into any shape, size, with lumens of any caliber and with collars cast on the tubes to facilitate their retention and discourage them from being passed. Spontaneous and premature passing of implanted tubes through the sphincter of Oddi into the duodenum is one of the real problems which we have encountered in the implantation of tubes of any type and material except those of the Y type. It is this tendency of implanted tubes to pass that has inclined us more and more in our later cases toward the use of T tubes which can be irrigated and tend less to be passed.

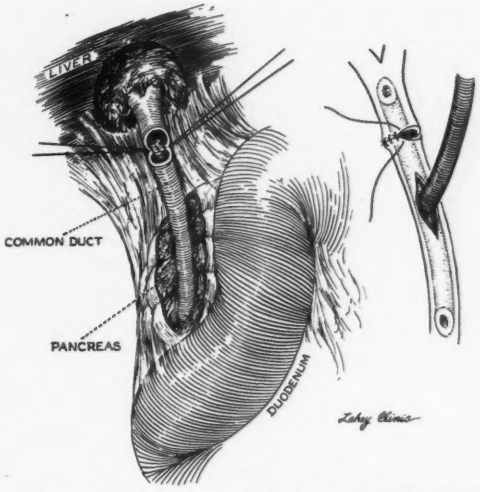


Fig. 15. In this diagrammatic illustration is shown the plan proposed by Cattell and Lahey of mobilizing the duodenum to the left, of recovering the uninjured portion of the common duct from the head of the pancreas by splitting it, the direct end-to-end anastomosis of the recovered common duct to the hepatic duct, and the introduction of a T tube with one limb passing through the line of anastomosis to maintain its patency.

### DESCRIPTION OF A NEW PRINCIPLE IN THE REPAIR OF STRICTURES OR LOSS OF SUBSTANCE IN THE BILE DUCTS

From time to time in discussions before medical societies of papers on bile duct strictures, Cattell (1,2) and one of us (7) have mentioned a plan which they have developed and employed of mobilizing the lower end of the common duct from the head of the pancreas, approximating it to the cut end of the hepatic duct and anastomosing the ducts by end-to-end suture. We have, however, refrained from publishing any detailed discussion of the method until it had been employed a sufficient number of times in a sufficient number of patients and over a sufficient period of years to test it to justify its description and to recommend its use. There will be many cases in which, because of previous unsuccessful operative attempts to repair duct strictures or to re-establish the bile tract by the implantations of tubes, this procedure of end-to-end anastomosis will be impossible or at least undesirably inaccurate. It is our opinion, however, after having successfully employed this plan in over 40[1] cases in which several previous unsuccessful operative attempts had been made at repair that it will be possible in many of the cases of duct injury to find and so mobilize the lower end of the common bile duct from the head of the pancreas that direct end-to-end anastomosis with fairly accurate suture and restoration of a mucous membrane-lined bile tract can be established.

A factor which has occasionally made it impossible at times to employ this procedure is that as the result of disuse the common duct when it is found within the head of the pan-

[1]For purposes of demonstrating feasibility, this figure includes the cases done up to the date of writing this paper, December 1949.

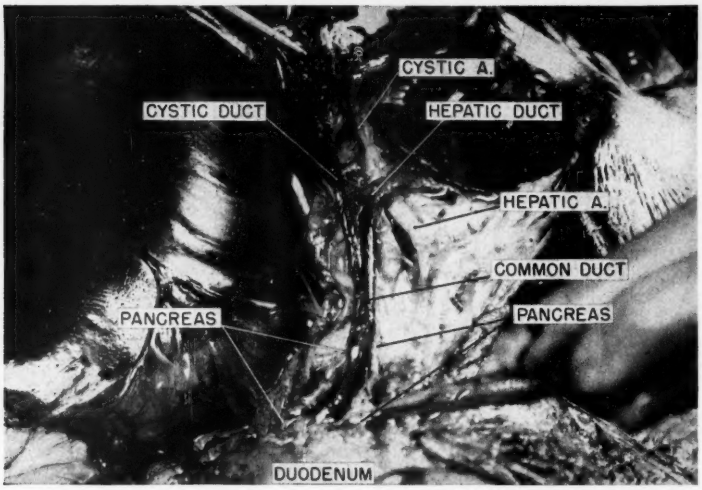


Fig. 16. Photograph of a dissection made on an autopsy specimen, showing the intrapancreatic dissection of the lower end of the common duct. While it does not show relationships well it serves to authenticate the diagrammatic drawing in Figure 15.

creas and behind the duodenum has been of such small caliber that it cannot, because of caliber dissimilarity, be satisfactorily anastomosed to the remaining large calibered stump of the cut hepatic duct. In doing this operation we have been impressed also with the fact that when these common ducts delivered from behind the duodenum are very small in caliber they do not lend themselves to stretching. This probably is the result of atrophy and fibrosis and is why they rupture when attempts to stretch them are made.

The basic principle of this plan, which has been developed jointly by Cattell and Lahey, is that that portion of the common duct which runs behind the duodenum and through the head of the pancreas to the sphincter of Oddi is so protected by its position in the head of the pancreas and behind the duodenum that no matter what the injury (crush or excision) may be to the other portions of the duct, this retroduodenal and intrapancreatic portion of the duct will in almost every instance be protected from injury, will remain intact, and, by mobilization from behind the head of the pancreas, will be available for use.

As we look back on our earlier experiences with these duct strictures and duct excision defects we, and every surgeon dealing with them, have in the past concerned ourselves too largely with finding the upper end of the injured ducts, the hepatic end, and have too frequently been too pessimistic about our ability to find the intact lower end of the duct, the common duct. We have too readily accepted our inability to bridge the gap defect in the duct by anything except tubes of foreign material, or with finding the upper end of the cut duct, giving up any attempt to find the lower end of the cut duct (the common duct) and implanting the hepatic duct directly into the duodenum or jejunum, thus sacrificing the good functioning sphincter of Oddi. We ourselves were of this frame of mind not too long ago. It is, we believe, such a tedious and painstaking procedure to find the lower end of a cut bile duct in the head of the pancreas that many surgeons hesitate to make the search for it or are intimidated by the distressing bleeding from the opened head of the pancreas and give up the search to turn to a simpler but less physiologic procedure, hepaticoenterostomy or the Longmire procedure of severing the left lobe of the liver, finding the left hepatic duct and implanting it into the jejunum.

It was not until we had learned how to find common ducts in the head of the pancreas and behind the duodenum—largely from our experiences in dissecting and demonstrating common ducts from the head of the pancreas in indurated duodenal ulcers adherent to them in order to remove the ulcer—that we discovered that the common duct could in most cases be so freed that it could frequently be brought up to the cut end of the hepatic duct sometimes even within the substance of the liver, for direct end-to-end repair by suture.

In the course of an experience with these 280 strictures of the common and hepatic ducts, we have learned to turn the duodenum over, to split the head of the pancreas as it projects to the right of the lateral wall of the duodenum, to find the common duct within the pancreas, and so to mobilize it out of the head of the pancreas and from the back of the duodenum that a surprising amount of intact common duct may be found, in many cases of such length and mobility as to make it possible to attach it to the remaining end of the hepatic duct so long as any of the common hepatic duct remains as a single tube (Fig. 12) or even a double tube.

The first step of any operation in which demonstration of the common and hepatic ducts after previous operations on the biliary tract is involved concerns itself with obtaining exposure of the region of the duct defect or injury without damaging the structures which must be dealt with before the common or hepatic duct can be found and dealt with, particularly the duodenum, hepatic flexure, portal vein, and hepatic artery.

The first step in obtaining an exposure of the region of the common and hepatic ducts in any patient who has had a previous operation on the biliary tract consists in finding the attachment of the hepatic flexure to the under surface of the liver at its outer edge. With gentle pressure to the left on a retractor placed upon a wet pad over the hepatic flexure, the line of adhesions of the hepatic flexure to the under surface of the liver can be demonstrated and gently separated from the liver edge and from below upward and inward by scissors or by means of a wiping swab (Fig. 5). This gentle wiping of the hepatic flexure away from

Fig. 17. The type of vitallium tube commonly employed in duct strictures. Note the projecting tab in spite of which, as stated in the text, these tubes have been passed through the common duct, through the sphincter of Oddi and into the duodenum.

the under surface of the liver along which is an established line of cleavage is continued until the point at which the duodenum is adherent to the under surface of the liver at its hilum is demonstrated. At this point the pyloric portion of the stomach is sought above (Fig. 12), where it is often adherent to the liver at the point at which the left lobe of the liver joins the right. This is gradually separated from the liver, by dissection from above downward until the duodenum is gradually safely and entirely freed from its attachment to the hilum of the liver and so wiped away and to the left that the entire region of the common duct, hepatic artery, and the foramen of Winslow are made plainly visible. It is at the point of attachment of the duodenum to the hilum of the liver that small spontaneous internal biliary fistulas are quite consistently encountered and must be dealt with by closure of the fistula into the duodenum by inversion suture.

We have over the years developed and employed this method of exposing common ducts at secondary operations on the bile tracts because we have had to do so many of these secondary operations upon the bile duct. It has proved useful and safe, even in patients who have had as many as six previous attempts at duct repair. It makes it possible to obtain safe re-exposure of the bile ducts in a relatively short period of time (Fig. 5). Once the duodenum and hepatic flexure have been

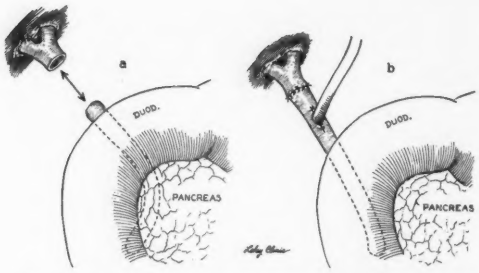


Fig. 18. Note in a, the curving course of the common duct through the head of the pancreas to the back of the duodenum, and in b, the amount of duct which can be gained as this duct is freed from the head of the pancreas so that it can be approximated to the cut end of the common hepatic duct.

detached from the liver and held to the left, the same maneuver of exposure as shown in Figure 5 by retraction on the liver to the right, the hepatic flexure and duodenum to the left, will expose the foramen of Winslow, will expose the common and hepatic ducts if they are intact and will expose the position where the ends of the ducts are to be sought.

At this stage of the procedure the first step should be the attempt to find and demonstrate the cut end of the hepatic duct in or near the hilum of the liver since the lower end of the duct, even if freed and mobilized from its position behind the duodenum and pancreas, is of no value unless the upper end of the duct, hepatic, can be found and demonstrated so that an anastomosis can be made to it. It is for this reason that the first effort should be to find and demonstrate an adequate amount of the stump of the hepatic duct.

At times the cut end of the hepatic duct may be found by following up to the hilum of the liver the fistulous tract, which at times extends to the external abdominal wall and at other times extends from its entrance into the duodenum up to the hilum of the liver. In many other cases the cut end of the duct will have closed completely and if there remains a sufficient portion, it can sometimes be identified by its clubbed end, not unlike the club-like end of a bass drumstick. At other times as a result of repeated unsuccessful attempts to repair the duct, the hepatic duct will be represented only by a mass of firm scar tissue in the hilum of the liver, with no identifying signs of what is and what is not hepatic duct. In such cases one is aided in discovering the duct by following the course of the hepatic artery as it is palpated or visualized up to the point where it disappears in the liver or by demonstrating the portal vein and following it up to the point where it disappears into the liver and searching just above it and to the right where the hepatic duct or ducts become intrahepatic. In other cases the duct will be discovered only by needling the liver at its hilum and the demonstration of the bile escaping from the needle or needle hole after the needle is withdrawn. In some cases, taking care to avoid the portal vein, it will be necessary to use a fulgurating loop to dissect away tissue at the hilum of the liver until the intrahepatic portion or portions of the duct or ducts can be demonstrated as a stump or stumps of the ducts.

The principle involved in the plan which Cattell and Lahey have developed is concerned, as already stated, with the demonstration of the retroduodenal and intrapancreatic lower portions of the common bile duct. This is the essential feature of the plan which makes demonstration and mobilization of the duct so possible that direct anastomosis of the demonstrated and mobilized common duct to the end of the hepatic duct can be employed. The first step in finding the common duct is the freeing of the second portion of the duodenum and so rolling it to the left, as shown in Figure 15, that the portion of the pancreas behind the outer part of the duodenum is exposed. With the duodenum so rolled to the left, the lower edge of the head of the pancreas can be split a little at a time until the intrapancreatic section of the uninjured portion of the common bile duct becomes visible and can be so dissected out of its position behind the duodenum and in the head of the pancreas that all that remains of it is completely demonstrated up to the point where it enters the wall of the duodenum (Fig. 16).

Dissection of the lower end of the common duct out of the head of the pancreas is tedious and troublesome. It is made so particularly by the large number of small vessels which bleed as the pancreas is divided longitudinally in the direction in which the duct runs, as shown in

Figures 12 and 15. With mosquito hemostats and silk ties and with patience, these troublesome vessels can ultimately all be safely controlled, although at times their complete control seems discouragingly impossible. We have many times been aided in the discovery of the intrapancreatic common duct by remembering its relationship as it runs in a roughly parallel course to the hepatic artery which can often be palpated within the scarred tissue caused by previous operative procedures, at other times by recognizing the entry of the duct into the duodenum as this structure is freed from the pancreas and rolled to the left and at other times by the demonstration of the course of the portal vein. It will never be necessary and is positively unsafe to detach the duodenum completely from the pancreas throughout its entire circumference lest its blood supply be so endangered as to result in necrosis of the duodenum.

When the common duct is found within the pancreas (Figs. 12 and 15) it can gradually be dissected out of it, a small slit can be made in its wall to demonstrate that a probe or a small catheter can be made to pass into the duodenum, the probe can then be passed upward to demonstrate the upper limits of the duct and the duct completely dissected out of the scar tissue up to its uppermost end. This is extremely important as the upper end of the duct will frequently be found to be deeply buried in the scar tissue of previous attempts at repair and it is important to obtain and preserve the greatest possible length of this duct.

It is to be recalled that the course of the duct through the head of the pancreas and behind the duodenum is an angulated one, and that when the duct is freed from this intrapancreatic position and carried directly upward to be approximated (Fig. 18) to the lower end of the hepatic duct, its course is much more direct than before it is mobilized and often makes it possible to gain 1, 2 or more inches toward the approximation of the ducts. It is also to be remembered that as the duodenum is mobilized from the head of the pancreas and rolled inward there will be another gain in the amount of duct available to approximate to lower end of hepatic duct.

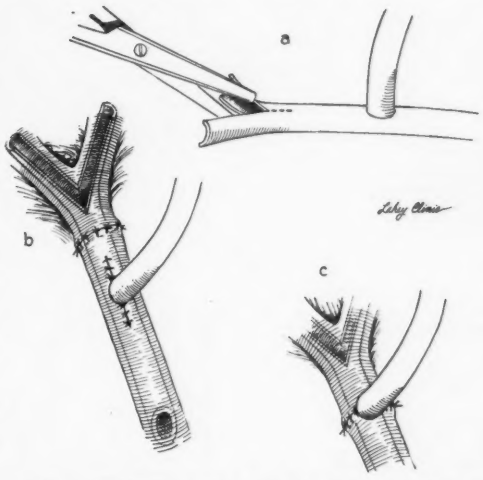


Fig. 19. This illustration serves two purposes, one, to show the method of splitting one limb of a T tube so that each end of the split tube can pass respectively into the right and left hepatic ducts when anastomosis must be made to a short stump of hepatic duct. It is in this type of injury also that the type of tube devised by Lahey may also be used, and is shown in Figure 9. The other purpose of this illustration is to show the wrong way of introducing the tube so that it emerges through the suture line, as shown in c, and the proper way of introducing the tube by the plan devised by Lahey in b, in which the tube emerges from a separate suture line and the line of anastomosis remains completely intact.

Once the common duct has been mobilized and the mobilization can be carried down to the point where the duct enters the duodenum, it is then necessary only to make the accurate end-to-end anastomosis with the hepatic duct after ascertaining that the ends of the ducts can be brought together without tension and that the lower end is of adequate caliber to match the upper end. This anastomosis is done by means of interrupted fine silk sutures, the back row being placed first, then a posterior row of interrupted catgut sutures to approximate mucosa to mucosa. A T tube is then introduced into a slit in the common duct below the end of the common duct so that the upper limb passes into the hepatic duct; the anterior line of interrupted catgut and silk sutures is placed about the tube to insure the absence of any narrowing of the reconstructed duct. This plan was described in an article on duct strictures published in 1949 (7), as shown in Figures 10 and 15.

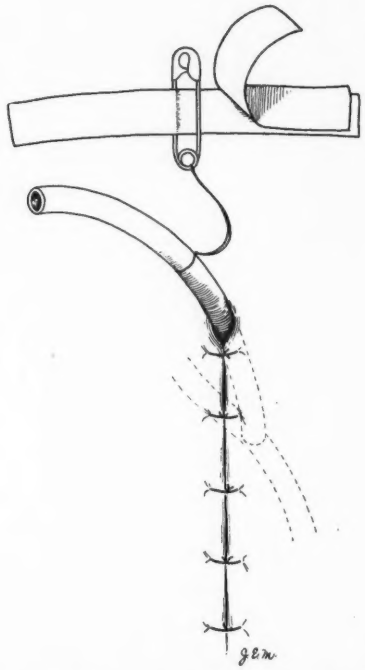

Fig. 20. In this illustration is shown the method devised to attempt to keep the T tube from being pulled out. A black silk stitch is tied accurately with sufficient pressure to hold but not sufficient pressure to occlude the tube. It is then tied to a safety pin which is maintained on the abdominal wall by two strips of adhesive plaster, one passing through the safety pin and one over it.

A suggestion made by C. E. Sedgwick, now a member of the permanent surgical staff of the clinic, while serving as an assistant to Lahey at the time of some of these trying operations, has proved of such great value that we have since employed it in all anastomoses of the ducts of this type. It consists of so wrapping the entire anastomosed section of duct in gelfoam strips that the suture line is temporarily reinforced. This has the advantage of aiding in making the suture line watertight until healing has taken place (Fig. 10b).

As shown in Figure 19 c, when we first began to repair crush strictures of the hepatic duct and to do plastic repair of the ducts, we introduced the two limbs of the T tube into the open ends of the ducts and reconstructed the anastomoses about the tube. Later we realized that when the tube was removed, even several months or a year later, there remained a defect in the duct wall which healed only by cicatrization. Because of this Lahey employed the plan of introducing the T tube, as shown in Figure 19, below the anastomotic line, permitting the upper limb of the tube to pass upward through the line of anastomosis to maintain its patency (described in *Annals of Surgery* in 1937, 4). This plan has been applied to the use of T tubes to support end-to-end anastomosis of the ducts and results in a complete circular and accurate anastomosis which remains intact when the T tube is withdrawn at a later date since the tube emerges from its slit in the duct at a point lower than that at which the anastomosis is made.

We have left the T tubes in place up to periods as long as 14 months after operation. We believe they should be left in place over a long period of time until the mucosa has grown well over the line of anastomosis and until the greatest possible degree of molding has taken place as a result of the presence of the T tube. We have instructed patients to irrigate the tubes gently night and morning with small amounts of sterile water or salt solution to aid in maintaining their patency.

Little need be said about the short crush type of stricture since we have already described a satisfactory plan for its management, as illustrated in Figure 6 c to f (100 per cent satisfactory results in the follow-up, Table VIII). Should this crush type of stricture involve any considerable part of the duct so that there is difficulty in obtaining enough lax duct to accomplish the plastic repair or should excision of the stricture seem the most satisfactory plan of obtaining good patency of the re-established duct, the lower end of the common duct can be mobilized as described, and a sufficient amount of duct obtained to accomplish direct end-to-end anastomosis.

It would be wrong in describing this operation to leave the impression that all one has to do is to find the end of the hepatic duct, to mobilize the common duct from its position behind the duodenum in the pancreas, to do an end-to-end anastomosis, and to put in a T tube and a satisfactory outcome automatically

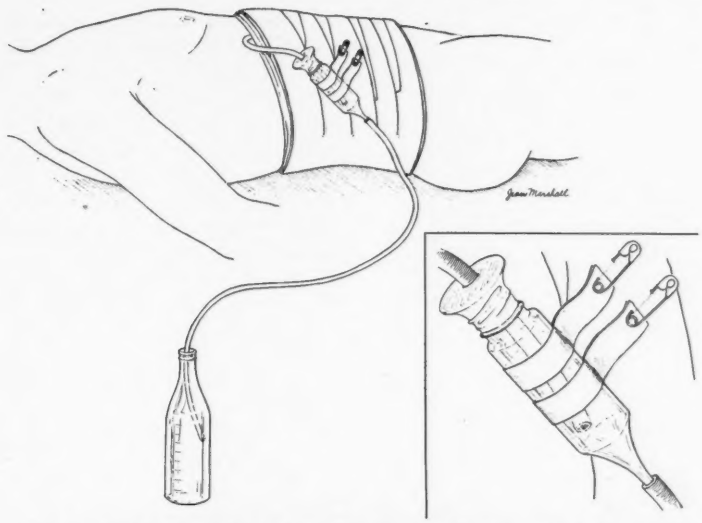

Fig. 21. In this illustration is shown diagrammatically the method of introducing the limb of the T tube into an asepto syringe, the mouth of which has been covered by a rubber dam and the tube placed in it, the syringe draining into a bottle. By this plan there is a break in the direct connection between the bottle and the T tube so that if the patient rolls from one side to the other, there will not be enough drag on the tube to pull it out of place. There are disadvantages to this method in that, as the patient rolls, not infrequently bile spills onto the bedclothes, requiring frequent changing.

would result. Unfortunately, anyone who has dealt with a number of these cases of stricture of the bile ducts knows that he is doomed to many depressing disappointments, one of the most frequent causes of which will be the presence of infection, mucus, bile mud, and even stones within the intrahepatic ducts above the injury to the ducts as a result of the infection and bile stasis associated with these strictures. In such a recent case, a very satisfactory anastomosis was accomplished. A T tube was left in place over a considerable period of time, but because of the fact that at the time the operation was done, numerous plugs of mucus and small gall stones were present and removed from the intrahepatic duct, immediately upon removing the tube, jaundice, colic, and chills reappeared. These complications were demonstrated to be the result of the infection and stones which continued to form within intrahepatic bile passages.

There have been 11 cases in which the patient, the nurse, or the surgeon has inadvertently pulled the T tube out of its place after operation, thus resulting in narrowing and in the need for reoperation and reintroduction of the T tube. For this reason, we wish strongly to urge that dependable measures be taken to insure the fixation of the tube to the abdominal wall in such a way that it will not be accidentally removed (see method described in latter part of paper, Figs. 20 and 21). In one of the cases the tube, due to the sticky bile, became adherent to the patient's undershirt and on taking off his undershirt, the T tube was pulled out, so that reoperation was necessary. In another the tube became adherent to the abdominal binder and as the nurse lifted the abdominal binder off, the tube was withdrawn. These accidents can occur in any case and should be guarded against because of the fact that too early withdrawal of the tube will permit stricturing again at the point of anastomosis.

Another precaution which must be taken in these cases is that of careful removal of the drain. Since in many of these cases there will

TABLE I.—ETIOLOGY OF STRICTURES

| | Cases | |
|---|---|---|
| Surgical trauma: | | |
| 1. Biliary tract surgery | 198 | |
| 2. Gastrectomy | 3 | |
| 3. Inflammatory | 7 | 208 |
| External trauma | | 2 |
| Primary inflammatory | | 2 |
| Adhesions | | 1 |
| Foreign body | | 1 |
| Congenital | | 1 |
| Fibrosis of ampulla | | 24 |
| Total | | 239 |

be considerable oozing from the under surface of the liver as a result of the separation of the hepatic flexure and the duodenum from the liver and as a result of the severance of the numerous adhesions in the region of the operation, and also since there is also frequently oozing from the small vessels in the edge of the pancreas as it is separated in finding the common duct, it will always be necessary to introduce a drain. On one occasion in the removal of the cigaret drain the T tube was accidentally pulled out with the drain. It is much better we now believe to employ gelfoam to control oozing and to make use solely of a Penrose drain without gauze for drainage rather than to employ a cigaret drain; the drain can then be withdrawn without danger to the indwelling T tube.

FOLLOW-UP DATA ON 229 REPAIRED BILE DUCTS

In an effort to evaluate the results obtained in applying the principles outlined in this paper and developed in this good-sized experience in reconstructive surgery of the biliary tract, and in an effort to learn whether these principles are sound, an intensive follow-up study has been made. Of the 280 patients operated upon for various types of bile duct strictures, 41 were treated in the years 1948 or 1949 and have been excluded from this study as too recent to be of value in determining end results, so that 239 patients are left for study. (We do not believe that a report on a method of bile duct repair is of value until the repair has existed for a period of 2 years.) As noted earlier in the text, 10 patients were lost to the follow-up study, so this leaves a group of 229 patients available for follow-up study. The study has been divided into two periods: the first extending from 1917 to 1939 and the second from 1940 to 1948. In the first period 54 patients were available for study, with 6 lost to the follow-up study, and in the second period 185 cases were studied with only 4 being lost to the follow-up study. Thus, for the entire series we are certain of the follow-up on 96 per cent of the cases and for the period from 1940 to 1948 we have succeeded in following 98 per cent of the cases by clinic visit, letter, or both.

The average age of this group of 239 patients was 43.8 years, of which 185 were women and 54 were men, or a ratio of females to males of 3 to 1.

It can be plainly seen in Table I that the majority of bile duct strictures, 208 in number, were secondary to biliary tract surgery; only 3 were secondary to partial gastrectomy. Eighty-one per cent of this series were due to operative trauma.

An investigation into the histories before the patients came to us was made to determine what the indications for the original operation on the gall bladder were and in 125 histories this information was available. There were 25 cases of acute cholecystitis (gangrene, perforation, and empyema included), and 100 cases of chronic cholecystitis or cholelithiasis, or both. Thus, 80 per cent of these 125 cases available for study had had what may be considered an elective operation, and 20 per cent were for an acute gall-bladder condition. In this entire series of traumatic bile duct strictures, in only 4 to 5 per cent of the cases was it recognized at the original operation that injury to the bile ducts had occurred. These figures indicate that in the majority of cases gall-bladder surgery is elective surgery and therefore can be performed as a deliberate and planned procedure. They suggest also that at the time of operation the anatomy was not carefully and plainly demonstrated because of the fact that such a small number of duct injuries was recognized at the original procedure.

In addition to the factors (described in the earlier part of the paper) which directly contributed to these duct injuries, that is hemorrhage from the cystic or hepatic artery, failure to demonstrate the cystic-common duct junction, and anomalies of the duct system, obesity

TABLE II.—TOTAL OPERATIONS PERFORMED INCLUDING THE ORIGINAL OPERATION

| | Number of patients | Operation elsewhere | Lahey Clinic | Total |
|---|---|---|---|---|
| 1919 to 1939 | 54 | 58 | 71 | 129 |
| 1940 to 1948 | 185 | 359 | 273 | 632 |
| Total | 239 | 417 | 344 | 761 |

with its added technical difficulties was present in 25 per cent of this group of cases of stricture of the bile ducts. Other factors such as the performance of choledochostomy in the presence of a very small common duct, trauma to the posterior wall of the common duct during choledochostomy, impacted stones at the cystic-common duct junction, gastrectomy and duodenectomy for low-lying duodenal ulcers and pancreatitis and acute cholecystitis with their associated edema of the gastrohepatic omentum obscuring the anatomy, were present in the operative reports in a few of the cases studied in this series.

Table II is of interest because it demonstrates what a patient with a bile duct stricture faces physically, financially, and mentally. It shows, for example, that from 1940 to 1948, 185 patients with bile duct strictures were treated at this clinic. Much as we dislike to insert this sentence it would be unfair to the surgeons operating in this clinic not to say that but 1 of these duct injuries occurred in this clinic and that it was immediately recognized and promptly and successfully repaired. This group of patients had had 359 operative procedures done before coming to the clinic and 273 operations were performed after coming to the clinic, or a total of 632 surgical procedures. The entire series of 239 cases of bile duct strictures had a total of 761 operative procedures. Table II indicates the serious responsibility accepted by a surgeon who undertakes this type of bile duct repair and what the patient must go through if the initial attempt at repair is unsuccessful. This total of 344 operations at the clinic on the injured bile ducts performed on 239 patients represents secondary operations in densely adherent, distorted, and complicated anatomy. Many of these patients were deeply jaundiced at the time of operation and had in many cases limited liver function. Several of these patients had had 3 or more (in one, 7, and in another, 8) previous operations on the biliary tract. In this entire group of cases there were 24 postoperative deaths in the total of 344 operative procedures, or a procedure mortality of 7 per cent. In the period from 1940 to 1948 there were 273 operative procedures on 185 patients with 12 deaths, or a procedure mortality of 4.4 per cent. Since each one of these operations is such a long and difficult one, and each succeeding one more difficult, it is unfair to report mortality in these cases except as procedure mortality.

TABLE III.—LOCATION AND GENERAL RESULTS —1917 TO 1948

| Location of stricture | Total | Results | | Postoperative deaths | No follow-up |
|---|---|---|---|---|---|
| | | Good to excellent | Unsatisfactory | | |
| Right hepatic duct | 7 | 3 | 2 | 1 | 1 |
| Left hepatic duct | 1 | 0 | 0 | 0 | 1 |
| Common hepatic duct at bifurcation | 28 | 19 | 3 | 6 | 0 |
| Common hepatic duct | 41 | 28 | 7 | 6 | 0 |
| Cystic-common duct junction | 18 | 16 | 0 | 1 | 1 |
| Common duct | 45 | 27 | 10 | 2 | 6 |
| Common hepatic and common duct | 25 | 20 | 3 | 1 | 1 |
| Extensive—common and hepatic ducts | 46 | 26 | 14 | 6 | 0 |
| Multiple strictures | 4 | 2 | 2 | 0 | 0 |
| Fibrosis of ampulla | 24 | 20 | 3 | 1 | 0 |
| Totals | 239 | 161 | 44 | 24 | 10 |
| Per cent | | 78.5 | | 10 | |

In this follow-up the results were graded as follows: excellent—asymptomatic; good—with mild symptoms, for example, pain, occasional chill without clinical jaundice, mild attacks of cholangitis at widely spaced intervals; unsatisfactory—recurrence of serious symptoms indicating obstruction, that is, severe chills, fever and obvious jaundice requiring reoperation or resulting in eventual deaths.

In Table III the locations of the strictures have been listed in every case and the results given for the entire group regardless of the type of repair. It may be seen from this table

TABLE IV.—RESULTS BY ALL METHODS FROM 1917 TO 1939

| | Number | Per cent |
|---|---|---|
| Total cases | 54 | |
| Postoperative deaths | 12 | 22 |
| No follow-up | 6 | |
| Cases for study | 36 | |
| Excellent results | 17 | 75 |
| Good results | 10 | |
| Unsatisfactory results | 9 | |
| Final results | | |
| Cases for study | 36 | |
| Excellent and good results | 23* | |
| Unsatisfactory results | 13 | |

*64% of cases for study (36) or 42.6% of total (54) cases.

that strictures have occurred at all levels in the extrahepatic biliary tree. The majority of strictures, however, were either of the common hepatic duct, the common duct, or extensive defects in which the entire extrahepatic and extrapancreatic section of the biliary tree had been excised or destroyed by repeated previously attempted reconstructive surgery. In the final end results it may be seen that 79 per cent of the cases followed had either an excellent or satisfactory result by all the various methods of reconstruction. There were 24 postoperative deaths, or 10 per cent for the entire series. The 10 cases which were lost to the follow-up and the 24 postoperative deaths were omitted in calculating these general results.

The two periods into which the cases have been divided are quite different in many ways, particularly as to the methods of repair employed. From 1917 to 1939 few of the principles now employed were used. In this early period a number of external biliary fistulas were transplanted and attempts were made to bridge duct defects with rubber tubing. During these early years of our experiences with these patients we were without the benefit of vitamin K and without as good an understanding of the importance of preparing a badly damaged liver for surgery as we now have. Finally, during these years we did not have the potent antibiotics of today. These factors account for an operative mortality of 22 per cent during the years 1917 to 1939. The three main causes of postoperative deaths in the early group were hemorrhage, liver failure, and peritonitis.

Table IV represents the results by all operative methods for this period from 1917 to 1939. A total of 36 patients in this group was available for study; the postoperative deaths and the 6 patients lost to follow-up were excluded. Twenty-seven patients were considered to have excellent or good results and 9 had grossly unsatisfactory results. In every instance in which the result was unsatisfactory, the patient died, and the average length of life was 25.5 months after attempted repair. When those patients who were thought to have good results, that is, with mild symptoms, were followed over long periods of time, 4 out of the 10 had died, the average length of life after repair being 9.6 years. The pattern of events in these patients who died was the same. The attacks of biliary tract obstruction became closer and closer together until jaundice was constant. The liver which gradually enlarged began finally to decrease in size as the spleen enlarged greatly. These patients were repeatedly hospitalized for hemorrhage, usually from the gastrointestinal tract, and death ensued from a massive gastrointestinal hemorrhage or from liver failure. Thus, of the patients who were thought after a brief follow-up to have a good (not excellent) result in this group of cases, 40 per cent had died when these patients were followed for 10 years or longer. It can be appreciated, therefore, since the average age of these patients in whom a stricture occurred was 43.8 years and in whom a satisfactory repair was not accomplished, that these patients with but few exceptions will die at an age far short of their life expectancy. The final salvage in this group of patients treated from 1917 to 1939 (Table IV) was 23 out of 54 or 42.6 per cent of the entire group of patients, a figure by no means to be critical of in the light of the period and the seriousness of their condition.

During the period from 1940 to 1948 the following principles of bile duct reconstruction now in use in the clinic were developed and applied: (1) direct duct end-to-end anastomosis with a T tube implanted through a separate opening in the bile duct (Fig. 15); (2) dissection of the intrapancreatic portion of the common duct, mobilization of the duodenum and end-to-end anastomosis of the

ducts (Figs. 12 and 15); (3) application of the Mikulicz principle by suturing the right and left hepatic ducts together and incising the sutured common wall between the two ducts thus creating a single lumen which could be anastomosed to the distal segment of the duct[1] (Fig. 7); (4) employment of vitallium and bouncing clay in reconstructive surgery of the bile ducts and direct anastomosis of the hepatic duct to the jejunum (Fig. 14). These 185 cases were analyzed as a group and each method was separately analyzed. A follow-up was accomplished in all but 4 cases, or in 98 per cent of this group.

Table V illustrates the results by all methods of bile duct reconstruction employed in 185 cases from 1940 to 1948. There were 12 postoperative deaths, or an operative mortality of 6.5 per cent. There were 273 operative procedures on 185 patients with a procedure mortality of 4.4 per cent. Of the 169 patients who could be followed, 138 had an excellent or good result, or 81 per cent had a satisfactory result by all methods of repair for all types of strictures. In the unsatisfactory group, there were 31 cases, of which 17 patients are dead (55 per cent) and 14 (45 per cent) are still alive with serious symptoms and have but a short prospect of life. As evidence of our increasing ability to handle these cases with safety, during the years 1947 and 1948, 71 patients were operated upon for stricture of the bile duct, with 1 postoperative death, or an operative mortality during those 2 years of 1.4 per cent.

In the following paragraphs and tables we have evaluated each separate type of procedure in the 1940 to 1948 series in order to satisfy ourselves whether or not the methods we are advocating and employing are sound in principle and results. The types of reconstruction which were evaluated were: (1) direct end-to-end anastomosis when enough duct was available (Fig. 15); (2) dissection of the distal common duct which lies within the pancreas and which usually remains uninjured, and mobilization of the duodenum when enough duct was not available without this (Figs. 12 and 15); (3) a plastic type of procedure employing the Heineke-Mikulicz principle (Fig. 6 c, d, and e); (4) dilatation and T tube insertion; (5) biliary-intestinal anastomosis (Fig. 14); (6) transplantation of external biliary fistulas (Fig. 13); and (7) bridging of defects of the bile duct by tube implantation (Fig. 11).

[1]Suggested and employed by Cattell in this clinic.

TABLE V.—RESULTS BY ALL METHODS FROM 1940 TO 1948

| | Number | | Per cent |
|---|---|---|---|
| Total cases | 185 | | |
| Postoperative deaths* | 12 | | |
| No follow-up | 4 | | |
| Cases for study | 169 | | |
| Excellent results | | 50 | 81.7 |
| Good results | | 88 | |
| Unsatisfactory results | 31 | | 18.3† |

*Procedure mortality, 4.4%, patient mortality, 6.5%,
†55% are dead, 45% living with serious symptoms.
From 1947 to 1948 there were 71 patients operated on with 1 postoperative death (1.4%).

In the past decade we have in this clinic repeatedly advocated the re-establishment of bile duct continuity by direct end-to-end, mucosa-to-mucosa anastomosis. When this procedure is feasible it preserves the important sphincter mechanism of the ampulla of Vater, and gives the most satisfactory and lasting results, even though it is occasionally later necessary to reoperate upon some of these patients and perform a plastic type of procedure upon the sutured ducts or dilatation of the narrowed anastomotic line with tube implantation, or both. Table VI illustrates the results in 78 patients who had as their initial operation an end-to-end anastomosis. Three postoperative deaths occurred and 2 patients were lost to follow-up so that 73 cases were left for study. Of this number, 44, or 60.2 per cent, had a satisfactory result without requiring further procedures. Thirteen required a secondary operation on the bile duct, either of a plastic nature or a dilatation of the anastomotic line with tube implantation, or for the removal of a plugged permanent type of tube (vitallium, bouncing clay, or rubber), before a satisfactory result was obtained. A total of 57, or 78 per cent, of these patients, had a good result by this plan of treatment. Six patients finally required a biliary-intestinal (jejunum) anastomosis before a satisfactory result was obtained. Of 73 patients, 63, or 86.2 per cent, had a good result when the initial procedure was an end-to-end anastomosis.

TABLE VI.—END-TO-END ANASTOMOSIS, FROM 1940 TO 1948

| | Number | | Per cent |
|---|---|---|---|
| Total cases | 78 | | |
| Postoperative deaths | 3 | | 3·9 |
| No follow-up | 2 | | |
| Cases for study— | | | |
| Excellent results | | 16 | |
| Good results | | 28 | 78* |
| Secondary operation on bile duct | | 13 | |
| Unsatisfactory results | | 16† | |
| Total cases for study | | 73 | |

*Of those studied 44, or 60.2%, obtained good results after one operation.
†6 of 16 patients had biliary intestinal anastomosis, with good results.

TABLE VII.—REPAIR BY DISSECTING LOWER END OF DUCT FROM PANCREAS AND END-TO-END ANASTOMOSIS

| | Number | | Per cent |
|---|---|---|---|
| Total cases | 27 | | |
| Postoperative deaths | 1 | | |
| Cases for study— | | | |
| Excellent results | | 3 | |
| Good results | | 10 | 73 |
| Secondary operation on bile ducts | | 6 | |
| Unsatisfactory results | | 7 | |
| Total cases for study | | 26 | |

The technical details for demonstrating the intrapancreatic portion of the common duct for the purpose of anastomosis to the proximal section of the duct (hepatic) have been described in detail earlier in this paper. Up to 1948 this procedure had been performed 27 times (Table VII), and it has been employed at least that many more times since that date. The latter cases, however, are not included in this study because they are too recent for follow-up study. Attention is called to the fact that in 21 of 27 patients the bile duct stricture was graded as extensive and in 21 of 27 cases two or more procedures (7 in one case and 8 previous operations in another) had been performed elsewhere before the patients came into our hands for further attempts at repair. Two methods were employed. In 21 cases a direct end-to-end anastomosis of the ducts was performed and in this group 80 per cent had a good result. In 6 cases after the distal bile duct had been mobilized from within the substance of the pancreas, a defect remained due to insufficient amounts of duct available between the proximal and distal ends of the duct. Satisfactory end-to-end anastomosis could not be made and a tube of rubber, vitallium or bouncing clay was used to bridge this gap. In these 6 cases, 5 were unsatisfactory. For the entire group of 27 cases, 73 per cent obtained a good result. It must be emphasized again and again that when this method is employed, if one hopes to obtain good results, complete duct continuity must be established without any degree of tension. If a defect exists in any part of the end-to-end anastomosis, if the anastomosis must be made under any tension, or if there is a considerable discrepancy in the caliber of the proximal and the distal duct (the proximal large and the distal small), this method should be abandoned and a biliary-intestinal anastomosis performed. As demonstrated by this experience and these figures, the outcome will otherwise be unsatisfactory.

From a study of Table VIII which shows the results with the plastic operation (Heineke-Mikulicz type) as the initial procedure, it can be seen that in 16 out of 16, good results were achieved. The majority of the strictures treated by this method, which consists of longitudinal incision of the stricture followed by transverse closure with a T tube implanted through a separate choledochostomy, were partial or very short strictures, the result often of clamp, crush, or narrowing of a sutured duct.

In the group of cases which were managed by simple dilatation and T tube implantation, the results were good in 80 per cent of the cases (Table IX). In this group are included the 24 cases of fibrosis of the sphincter of Oddi.

Table X represents the results in those cases in which a biliary intestinal anastomosis was performed as the primary procedure. Satisfactory results were obtained with this type of procedure in 73.1 per cent of the cases in which it was employed. In the majority of these cases the proximal duct was anastomosed to a long antecolic loop of jejunum and an entero-enterostomy was placed below the biliary intestinal anastomosis. Although the results with this method (73.1 per cent) are nearly as good as those obtained with end-to-end anastomosis (78 per cent), this method does not preserve the sphincter mechanism of the am-

TABLE VIII.—PLASTIC OPERATION FOR STRICTURE OF THE BILE DUCT (HEINEKE-MIKULICZ METHOD) FROM 1940 TO 1948

| | Number | Per cent |
|---|---|---|
| Total cases | 17 | |
| Postoperative deaths | 1 | |
| Cases for study— | | |
| Excellent results | 6 | 100* |
| Good results | 6 | |
| Secondary operation on bile duct | 4 | |
| Total cases for study | 16 | |

*Of those studied 12, or 75%, obtained good results after one operation.

TABLE IX.—DILATATION AND TUBE IMPLANTATION FROM 1940 TO 1948

| | Number | Per cent |
|---|---|---|
| Total cases | 41 | |
| Postoperative deaths | 1 | |
| Cases for study— | | |
| Excellent results | 11 | 80* |
| Good results | 19 | |
| Secondary operation on bile duct | 2 | |
| Unsatisfactory results | 8 | |
| Total cases for study | 40 | |

*Of those studied 30, or 75%, obtained good results after one operation.

pulla which is so important in preventing regurgitation and recurrent episodes of cholangitis. In our hands, however, this plan has been the method of choice when satisfactory duct-to-duct anastomosis has been impossible and has as well been an expedient method for an extremely poor risk patient, or for the patient who would not tolerate a long and trying operative procedure well.

From 1940 to 1948 defects between the ends of the proximal and distal portions of an anastomosis were bridged by tubes in 10 cases (Table XI). The results were good in only 20 per cent of the cases. This procedure should, we believe, take its place with the operation of transplantation of an external fistula as an unsatisfactory procedure since neither of these methods offers the patient an adequate chance for a satisfactory and lasting result.

In the period from 1940 to 1948 external fistulas were created in only 3 cases. The results were unsatisfactory in all 3 cases. In these cases no duct whatever, either common or extrahepatic, could be found because of the extensive nature of the stricture and scarring, the results of previous attempts at repair before the patient came to us, and this measure has been employed as a last resort maneuver. It is well, however, to remember that occasionally it may be necessary to introduce a tube temporarily into the proximal duct (hepatic) in the extremely ill patient, or in the patient who has a purulent cholangitis. This will serve to decompress or drain the liver and, following the improvement obtained by this procedure, a reconstruction or duct to jejunum anastomosis may be undertaken. There have been 2 instances in the past year in which this plan has been employed.

## COMPLICATIONS

Because these results are more satisfactory than one might expect we would not have anyone believe that reconstructive surgery of the bile duct is not without its depressing complications, fatal and nonfatal. The nonfatal complications increase the morbidity of these cases materially and these surgical procedures are unavoidably trying from the point of view of both the patient and the surgeon.

In Table XII are listed the fatal complications in the two periods under study, that is 1917 to 1939 and 1940 to 1948. There were 12 postoperative deaths in each of the two periods. During the period from 1917 to 1939 the leading cause of death was hemorrhage, and this accounted for 5 of the 12 deaths, whereas from 1940 to 1949 only 2 patients died as a result of hemorrhage postoperatively. This difference is explainable on the basis of a single factor, vitamin K. This vitamin was not available in the period from 1917 to 1939. The second important factor accounting for postoperative deaths in the two periods was liver failure. We now have a very much better understanding of the importance and method of preparing a patient with a badly damaged liver for surgery than we did in this era. The medical services are now responsible for preparing these patients for surgery by means of an intensive liver regimen. This regimen includes the dietary measures of supplying the patient with a palatable high protein, high carbohydrate, low fat (40 gm.) diet. To this diet are added all the vitamins, particularly C and B complex. In addition, oral and intravenous protein feedings are given, choline is added and crude liver given intramuscularly daily. Finally, the necessary blood transfu-

TABLE X.—BILIARY-INTESTINAL ANASTOMOSIS (JEJUNUM AND DUODENUM) FROM 1940 TO 1948

| | Number | Per cent |
|---|---|---|
| Total cases | 45 | |
| Postoperative deaths | 3 | 6.6 |
| No follow-up | 1 | |
| Cases for study— | | |
| Excellent results | 10 | 73.1* |
| Good results | 16 | |
| Secondary operation on bile duct | 4 | |
| Unsatisfactory results | 11 | |
| Total cases for study | 41 | |

*Of those studied 26, or 63.4% obtained good results after one operation.

TABLE XI.—DEFECT BRIDGED BY TUBES FROM 1940 TO 1948

| | Number | Per cent |
|---|---|---|
| Total cases | 10 | |
| Postoperative deaths | 0 | |
| Excellent results | 0 | |
| Good results | 2 | 20 |
| Unsatisfactory results | 8 | |

sions are given to bring the patient's blood picture to as near normal as possible before operation. On this program most of these patients are able to tolerate these extensive procedures which at times are long and during which the blood loss may be serious.

The next most frequent fatal complications in these two periods were sepsis and peritonitis. It is important to note in the period from 1940 to 1948 that 3 patients died of sepsis. These deaths occurred in the earlier years of this series before we had the benefits of large amounts of penicillin and streptomycin. As stated earlier in the paper in the 2 years 1947 and 1948 there was but 1 postoperative death in 71 patients operated upon for strictures of the bile duct and this was caused by liver failure and postoperative shock.

The nonfatal complications have been listed in Table XIII. There were a great many more complications listed for the period 1940 to 1948, during which time 273 operative procedures were carried out on 185 patients. Prior to 1940 it was our plan to restrict the dissection of the right upper quadrant largely to the immediate area of the bile ducts, thereby making the operation almost extraperitoneal. This plan has been changed in the latter years to one by which the dissection of the right upper quadrant is quite complete, restoring all of the anatomy to as near normal as possible before the search for the divided duct is begun. This method has postoperative disadvantages because it opens up the general peritoneal cavity and leads to accumulations of serum, bile, and purulent material in the pelvis, under the diaphragm and under the liver. It does, however, permit anatomical visualization of all of the important structures here such as portal vein, hepatic artery, and the duct remnant. The frequency of these complications may be seen in Table XIII.

Wound infections have not been uncommon. However, if gauze drapes are used and applied early, and if these drapes are made so that a sheet of cellophane is incorporated between the layers of the gauze (F.H.L.), thus making the wound drape impervious, this complication will be less frequent. This complication, wound infection, occurred twelve times in 273 operative procedures. The use of steel wire in the last 2 years has definitely lessened the incidence of serious wound complications.

The bleeding tendency of these patients with prolonged jaundice and severe liver damage must obviously be treated vigorously with vitamin K preparations for prolonged periods before and after operation, as well as with fresh blood transfusions. Nonfatal hemorrhage occurred eight times in this series of cases.

T tubes are used frequently in the reconstructive surgery of the bile duct. When the T tube is dislodged or accidentally pulled out during the postoperative period, the patient is faced with the prospect of a recurrence of the stricture and further operation will be required regardless of how well the anastomosis has been made between the divided ends of the duct. The majority of these tubes have been pulled out while the patient sleeps and unconsciously rolls from side to side in bed. We are now placing the free end of the T tube into a small asepto syringe which is strapped to the patient's dressing, and the distal end of the asepto syringe is attached to the drainage system. The T tube is held to the abdominal wall by a piece of silk tied to the T tube and to a safety pin and the safety pin is strapped to the abdominal wall adjacent to the incision

TABLE XII.—FATAL POSTOPERATIVE COMPLICATIONS

| | 48 cases, 1917 to 1939 | 181 cases, 1940 to 1948 |
|---|---|---|
| Liver failure | 2 | 3 |
| Hemorrhage | 5 | 2 |
| Sepsis | 0 | 3 |
| Bile peritonitis | 2 | 0 |
| Hepatorenal syndrome | 1 | 1 |
| Shock | 1 | 1 |
| Empyema | 1 | 0 |
| Cerebrovascular accident | 0 | 1 |
| Undetermined | 0 | 1 |
| | 12 | 12 |

TABLE XIII.—NONFATAL POSTOPERATIVE COMPLICATIONS

| | 48 cases, 1917 to 1939 | 181 cases, 1940 to 1948 |
|---|---|---|
| Extrusion of T-tube | 0 | 11 |
| Proximal arm of T dislodged by drain | 0 | 2 |
| Nonfatal hemorrhage | 4 | 8 |
| Hepatitis and cholangitis | 1 | 8 |
| Subhepatic abscess | 2 | 3 |
| Subdiaphragmatic abscess | 0 | 3 |
| Pelvic abscess | 0 | 5 |
| Peritonitis | 0 | 3 |
| Empyema | 0 | 1 |
| Wound infection | 0 | 12 |
| Gas bacillus infection | 0 | 1 |
| Wound evisceration | 0 | 2 |
| Partial separation | 0 | 2 |
| Intestinal fistula | 0 | 4 |
| Atelectasis | 1 | 7 |
| Bronchopneumonia | 1 | 3 |
| Pulmonary infarct | 0 | 2 |
| Pleurisy right base | 0 | 2 |
| Thrombophlebitis | 0 | 3 |
| Shock | 1 | 2 |
| Acidosis secondary to bile loss | 0 | 3 |
| Severe febrile reaction—etiology not determined | 0 | 4 |
| Psychosis | 1 | 2 |

(Figs. 20 and 21). This plan of management of the T tube, suggested by C. E. Sedgwick in this clinic, provided a great added measure of safety during the postoperative management of these tubes. It does have the disadvantage that the tube not infrequently gets pulled out of the asepto syringe and soils the sheet but this is better than pulling the tube out of the wound.

Not infrequently these patients will have an exacerbation of their jaundice with high fever immediately after surgery and little bile will drain from the implanted T tube. This has been interpreted as hepatitis with cholangitis and we have treated these patients vigorously with large doses of penicillin and streptomycin.

As may be seen from Table XIII pulmonary complications are relatively frequent. These patients are encouraged to take breathing and leg exercises and they should be turned frequently. When serious atelectasis occurs it becomes immediately necessary to do tracheal aspirations with a catheter or by bronchoscope. Early ambulation is individualized for each patient; if they are vigorous they are allowed out of bed on their second or third postoperative day, if they have been chronically ill with serious jaundice ambulation is delayed. We would mention, finally, that the blood chemistry findings must be carefully followed in these patients. The loss of bile from an implanted T tube may be great. Large quantities of sodium may be lost with serious acidosis as a result. The electrolytes lost in the bile must be replaced by the ordinary saline and glucose solutions as well as by applying calculated amounts of balanced solutions such as Hartmann's or one-sixth molar lactate solution.

## SUMMARY

From an analysis of this quite complete follow-up study of our cases, we feel that we have established to our satisfaction that the principle of re-establishing bile duct continuity by end-to-end anastomosis and in this manner preserving the sphincter of Oddi is a sound one.

From this same study we have satisfied ourselves that it is feasible in most of the patients coming to us for repair to isolate uninjured segments of the common duct by finding the intrapancreatic portion of the common duct and thereby accomplish end-to-end anastomosis with good results.

This study has shown that anastomoses of the stump of the hepatic duct to the jejunum may be accomplished in those patients in whom an end-to-end anastomosis is not feasible and a quite satisfactory end result anticipated.

This study has served to prove that it is unwise in terms of an expected satisfactory result to bridge duct defects by any type of tube to preserve continuity of the bile ducts.

Finally, a patient who has had an injury to his bile duct will have the best chance for a permanently good result if the initial repair is done at the time of injury or as soon after the injury as possible and if it re-establishes the continuity of the bile ducts and preserves the sphincter. If this is not accomplished and recurrence of the stricture takes place, the patient then is faced with at least one or two operations, a badly distorted operative field, and the chance for a permanently good result will diminish with each additional surgical procedure.

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# VAGINAL HYSTERECTOMY

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VAGINAL hysterectomy has become again an appealing method for disposal of the uterus. Developed at one time because of the dangers of abdominal surgery, this technique has languished somewhat because of the more interesting vistas revealed by the lower abdominal incision. However, since the majority of patients coming to gynecological surgery need vaginal plastic work as well as removal of the uterus, there has been a return of interest in the vaginal route of removal. Heaney probably more than any other living gynecologist has been responsible for this. In the author's personal series of over 300 vaginal hysterectomies without a death, morbidity and hospital stay have been shortened markedly over previous transabdominal procedures. The end results of vaginal hysterectomy for nonmalignant indications have been as satisfying as those performed abdominally. Actually, it is a moot point whether the supports of the apex of the vagina unite in better fashion when assembled from the transabdominal or from the vaginal route provided the operator identifies, preserves, and approximates the supports carefully. This experience simply duplicates in lesser order the astounding series reported by Heaney and his associates, Danforth, Averell, Campbell, and many others.

Figure 1 demonstrates the method of evaluation of the pelvic floor structures and their supports. Defects in the musculofascial supports of the bladder start just in front of the cervix and work forward. Hence, the examining finger can develop knowledge of this separation of the median raphe by simple pelvic examination. The urethra often is avulsed from its supports, an easily ascertained fact with the ordinary probe. Avulsion or attenuation of the lateral supports of the uterus—the cardinal or Mackenrodt ligaments—may be tested either by having the patient bear down while in the standing position, or by the examiner's grasping the cervix with a tenaculum and duplicating the downward pressure of the erect position. The nearer the introitus the cervix approaches, the greater the need for shortening and reattaching these vital supports. Herniation of the pouch of Douglas occurs between the uterosacral ligaments. This defect often cannot be evaluated adequately until those structures are exposed by opening of the posterior cul-de-sac or by exposure of that area in the dissection for rectocele repair. Reapproximation of these ligaments closes this potential or actual space against downward protrusion of pelvic contents.

The split in the perineal-posterior vaginal supports begins at the vaginal outlet and works inwardly in contradistinction to the mechanism causing cystocele. Again, the examiner's finger can evaluate this split in the supports as accurately as one measures a defect of the umbilicus or of the inguinal canal. Reapproximation of the posterior vaginal fascia to the new apex of the vagina must be sufficient to obliterate this defect, and the important perineal muscles must be refreshed and reattached in the midline to give a vaginal canal of smooth configuration and of two fingers' caliber. The obliteration of overstretched lateral fornices must be accomplished as well. Figure 1 demonstrates these common defects diagrammatically. Their occurrence may embrace only one or any combination of them. In other words, one's pelvic examination should routinely evaluate and record these six points.

Figure 2 demonstrates diagrammatically the essential supports of the uterus, and hence after its removal, the supports of the vaginal vault. If these are approximated—and such is done equally easily from the abdominal-pelvic approach or from the vaginal—then the new apex is created without shortening. Essential points of technique include the attachment of the pubocervical fascia to this new sling support, obliteration of the cul-de-sac by tying in of the uterosacral ligaments, and attachment of the rectovaginal fascial supports to this new apex. If this is done, as demonstrated in Fig-

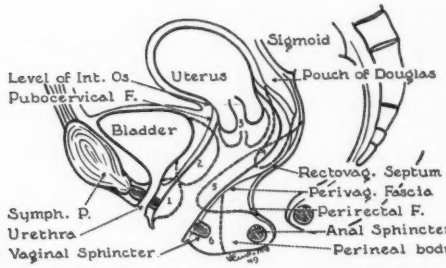


Fig. 1. Disorders of pelvic planes: *1*, urethrocele; *2*, cystocele; *3*, uterine prolapse; *4*, enterocele; *5*, rectocele; *6*, perineal laceration (reapproximation vaginal constrictor muscle).

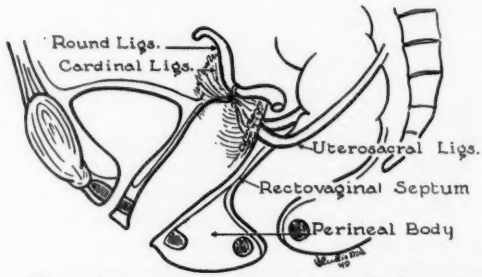


Fig. 3. Postoperative architecture. Standard measurements: one finger, 3 inches deep or ¾ by 3 inches. Treatment with estrogens locally as indicated to soften scars.

ure 3, then a firmly supported pelvis is created without shortening of the canal.

### TECHNIQUE

These modifications in established techniques came as a result of teaching beginning gynecologic surgeons. Procedures done with exquisite grace by the expert gynecologic operator had significant danger points for the beginner. The dissection of the bladder from the anterior uterine surface, the opening of the anterior cul-de-sac, sufficient visualization of the operative field, control of the uterus, correction of enterocele—these and other problems harassed the beginner.

Essentially, the points of technique to be elaborated are:

1. Utilization of the posterior colpotomy wound as the "exploratory laparotomy" incision to accomplish delivery of the uterine fundus. When the uterosacral ligaments are cut free from the uterus, not alone does the entire uterus descend, but a 2 to 3 inch incision appears through which the fundus can be delivered by retroversion.

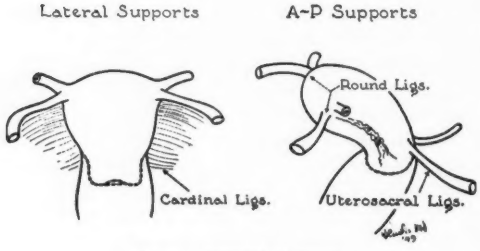


Fig. 2. Supports of uterus.

2. Ease of opening the anterior cul-de-sac which is distended over the operator's fingers introduced through the posterior incision. This seemed to eliminate in large degree the apprehension of the beginning operator.

3. A method of creating the vaginal vault using all the previous supports of the uterus as well as a method of suturing the overstretched or attenuated cardinal ligaments to the pubocervical fascia of the opposite side in order to shorten them and to heighten the new apex of the vagina. It is extremely difficult to remove any portion of these overstretched ligaments without danger to the ureters. Hence, it would seem reasonable to attach one ligament to the pubocervical fascia of the opposite side, that attachment being as high as the operator feels necessary to correct the overstretching of the ligament. Rather than carry these structures forward to unite under the symphysis or to reinforce the bulk of tissue under the floor of the bladder, which often results in the shortening of the vagina, the operator must suture these structures laterally reduplicating their normal attachment at the three or nine o'clock positions of the cervix. Then, when they are tied in place, the natural vaginal apex is carried upward. Securing sutures are employed to unite these crossed structures at the apex of the vagina so that they are doubly fixed.

No one technique is suitable for all cases and no one technique fails to partake of the details given by previous operators. The writer assumes the familiarity of the reader with the closed technique of Heaney, with the clamp hysterectomy of Price described so well by

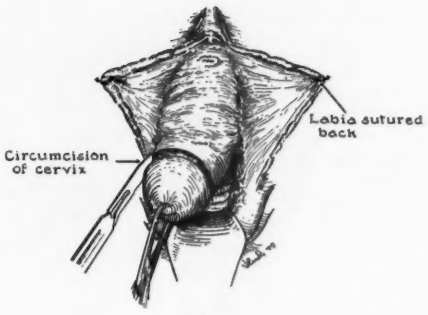


Fig. 4.

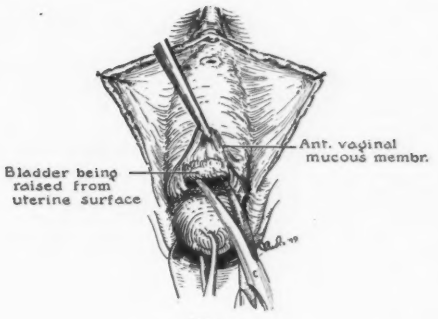


Fig. 5.

Kennedy and Campbell, the Mayo technique, and the many other procedures. Possibly the only addition herein is the method of utilizing the cardinal ligaments. Certainly the assembly and order of the steps in the procedure bring no new concept but suit the wish of the surgeon and are modified by the technical problems of any given patient. The pattern of steps given here assumes need for repair of the entire pelvic floor, but can be edited for the individual pathological sequence whether it be malposition or malfunction of the uterus as well as pathologic condition. It may be emphasized that this routine can be performed without the element of uterine prolapse, although the nulliparous patient with the large fibroid may still better be handled by the Heaney technique, morcellation, and so forth.

Figure 4 demonstrates complete circumcision of the cervix with the sharp knife, the incision being made precisely at the point where the vaginal plications and the vaginal mucosa merge with the cervix. If too high, there is danger to the bladder; if too low, the dissection of the mucous membrane from the cervix becomes academic and bloody. Figure 5 demonstrates the raising of the bladder from the cervix, and once the cleavage plane is established the bladder is pushed back gently with dry gauze over the surgeon's finger. No effort is made to enter the anterior cul-de-sac nor to dissect that high upon the uterus at this time. Bleeding is minimal if one is in the correct cleavage plane, although precise hemostasis should be maintained. The writer prefers to leave any further bladder dissection until after the hysterectomy, feeling that blood loss and tissue drying are less. Figure 6 demonstrates the method of entering the posterior cul-de-sac which is accomplished easily if the cervix is drawn upward vigorously and the incision is made just behind the cervix but not into the uterine substance. A defect between the uterosacral ligaments is palpated easily should there be doubt. If the patient has had previous pelvic surgery, one must decide from the mobility of the uterus and the adnexae whether the patient is suitable for vaginal hysterectomy, and if suitable, whether to open through the anterior or posterior cul-de-sac. It has been the writer's experience that the latter is less frequently obliterated or filled with hazardous adherences than the former. Figure 7 shows the clamping of the uterosacral ligaments and immediate stitch ligation, leaving the suture ends dangling with marking clamp attached. Some of the cervical blood vessels

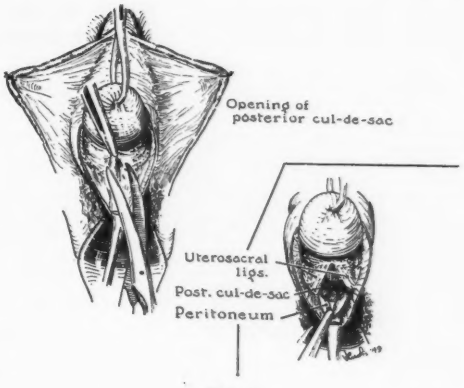


Fig. 6.

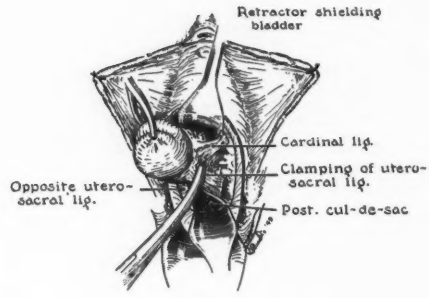


Fig. 7.

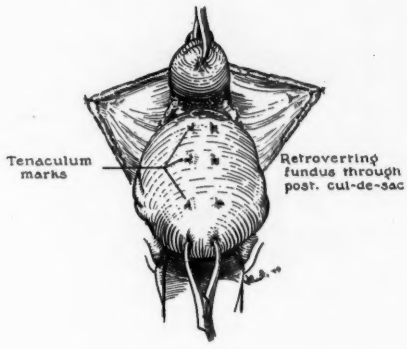


Fig. 8.

or part of the cardinal ligaments may be involved in this clamp with no harm. Once both uterosacral ligaments are cut free two results are achieved—the uterus lowers about an inch and an incision is created which can be enlarged with traction to several inches or more. The palpating finger then is able to check adnexal position, fixation and pathology, as well as uterine problems. No harm is done if decision is made here to complete the procedure through the anterior cul-de-sac or by the abdominal route. This method of evaluating the pelvic picture has been most helpful and precise, for with little effort the adnexae can be brought into direct view. Reattachment of the ligaments in creation of the new vaginal apex can be accomplished either from below or from above after the hysterectomy is completed.

Figure 8 demonstrates the uterus retroverted through the posterior cul-de-sac by a hand-over-hand application of tenacula. Should these instruments abuse the uterine muscle and cause bleeding, successive figure-of-eight traction sutures can be employed. With a retractor in the posterior portion of the incision, bowel is protected and the retroversion is done under direct vision. If the patient is placed in Trendelenburg position for this step, other abdominal viscera gravitate upward without conflict. Figure 9 shows the operator's fingers in the anterior cul-de-sac and with proper retraction of the bladder, the peritoneum can be incised under direct vision. This seems to be a great comfort particularly to the beginning operator. With the uterus in the palm of the operator's hand, so to speak, easy manipulation is possible and application of clamps to the parametrium much facilitated, as shown in Figure 10. Usually one clamp incorporates the ovarian and round ligaments, and the next clamp the uterine vessels and cardinal ligaments. If the uterus is quite large, the uterine vessels may be clamped and stitch ligated as an individual step. The pedicles are doubly stitch ligated with No. 1 chromic catgut, the second being left long and grasped by a marking hemostat for further reference, as in Figure 11.

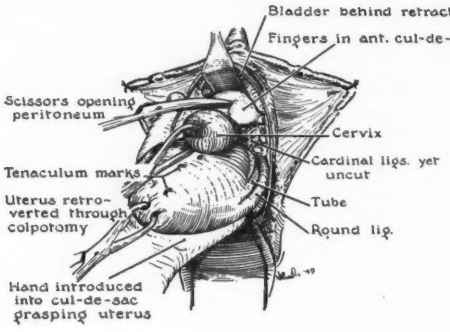


Fig. 9.

Figure 12 demonstrates the method of visualization of the tube and ovary for removal or for salvage. If they are to be removed, the pedicles are clamped beyond these structures and the double stitch ligation performed. Resection of cysts, salpingectomy and the like are accomplished with little difficulty.

Figure 13 shows the method of pursestring closure of the peritoneal cavity using one suture which catches the anterior and posterior

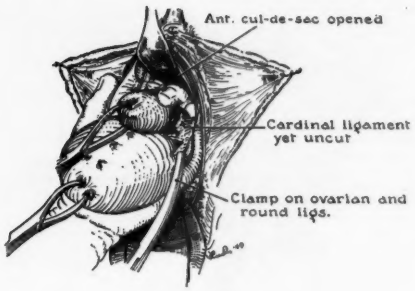


Fig. 10.

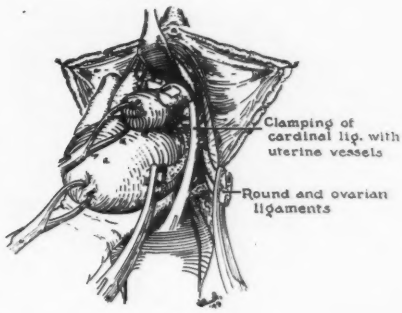


Fig. 11.

peritoneal leaves, and also catches the peritoneum of the tube just beyond the stitch ligature. In this fashion, when tied, the suture obliterates the peritoneal cavity, and from here on the procedure is extraperitoneal. If enterocele is present, the sac is excised before closure of the peritoneal cavity. Before creating the new supports of the vaginal apex, attention is given to reapproximation of the bladder supports not only in correcting any split of the median raphe, but ultimately the reattachment of the pubocervical fascia to the cardinal ligament sling. Figure 14 begins the bladder dissection with opening of the mucosa upward to a point where the vaginal plications end. The bladder reflects easily from the mucosal flap if the right cleavage place is found. In Figure 15, the Kelly plication of the urethra has been accomplished in the classical fashion but by the use of two or three sutures of No. 0 chromic catgut. If the cystocele is large, the bladder fascia may be reefed as well by using a running suture. Already placed, too, are the sutures which catch the undersurface of the mucosal flap as far laterally as the reflection of the bladder from this flap. In the midline, where the defect in the fascia is located, only mucous membrane remains, whereas the torn fascial edges have retracted laterally. The stitches are placed on the undersurface of the flap, thus catching the fascial edges. This has seemed less detrimental to fascial blood supply than dissection of the fascia as a separate layer. The upper fascial stitch is placed deeply trying to catch the periosteum of the pubis in order to reattach the urethra to the undersurface of the pubis.

In Figure 16, the cardinal ligament of the one side is sutured to the fascia of the opposite side as high as the judgment of the operator dictates to shorten its attenuation. This is the critical step in the procedure. The opposite cardinal ligament is treated in similar fashion, and tied. Then the marked stitch ligatures on the cardinal ligaments are tied together, one is cut. Then the marking ligatures on the round and ovarian ligaments are tied, one is cut and the remaining one is tied forward with the cardinal ligament. Then the uterosacral ligatures are tied, one cut, and the remaining ligature tied forward to the round ovarian ligament ligature. In this fashion, all of these supports approximate with minimum tension after the cardinal ligaments have been shortened. With closer approximation of the uterosacral ligaments, the possibility of enterocele is diminished. Some idea of the firmness of support may be gained by traction on the remaining ligature before it is cut. This attachment of the cardinal ligaments lifts precisely

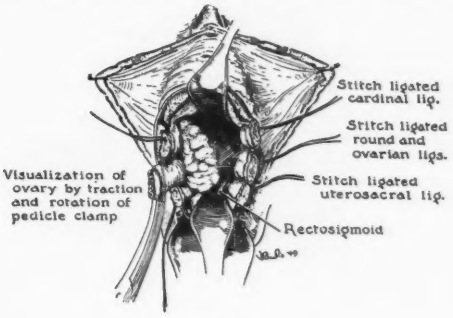
Stitch ligated cardinal lig.
Stitch ligated round and ovarian ligs.
Visualization of ovary by traction and rotation of pedicle clamp
Stitch ligated uterosacral lig.
Rectosigmoid

Fig. 12.

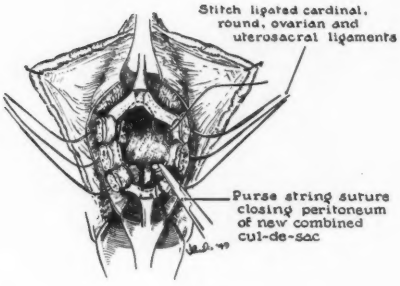
Stitch ligated cardinal, round, ovarian and uterosacral ligaments
Purse string suture closing peritoneum of new combined cul-de-sac

Fig. 13.

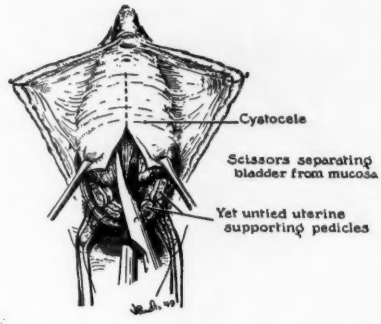


Fig. 14.

the apex of the vagina to any height desired by the operator without his reliance upon any shrinking or cicatricial action to do so.

In Figure 17, the suture attaching the pubocervical fascia to the new apex is laid in and then the remaining deep fascia sutures are tied as they are encountered in the progressive upward suture of the cut edges of the mucosal flap which now is both mucosal and fascial.

One must perforce build up the posterior supports should there be any weakness and Figure 18 begins the dissection of this compartment. One again can accurately palpate the separation of the posterior vaginal fascia from its midline raphe and dissection must go well above this in order to be complete. In Figure 18, the crown stitch has been placed just behind the new vaginal apex down through the mucosal-fascial flap to grasp the levator muscles on either side. In the event of a large rectocele, the perirectal fascia may be plicated as additional support, although the interposition of the levator and perineal muscles seems adequate in the majority of cases. With the attachment of the rectovaginal septum to the new apex of the vagina, a second barrier to enterocele is formed, and the lateral fornices are taken in as well. These progressive steps are shown in Figures 19 and 20.

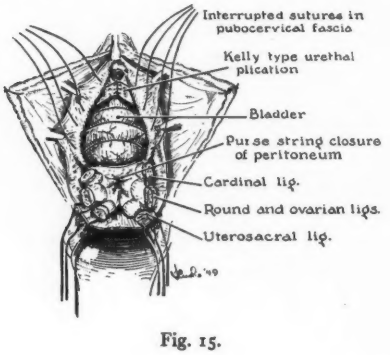


Fig. 15.

### DISCUSSION

Vaginal hysterectomy is viewed with considerable suspicion by those in whose hands the abdominal approach has been satisfactory. A number of objections had to be overcome in the writer's mind because his original training had emphasized the advantages of transabdominal hysterectomy. These objections are worth considering in the light of increasing experience with the vaginal approach.

1. The danger of prolapse of the vaginal vault. Since every effort is made to utilize the same supporting structures to recreate the

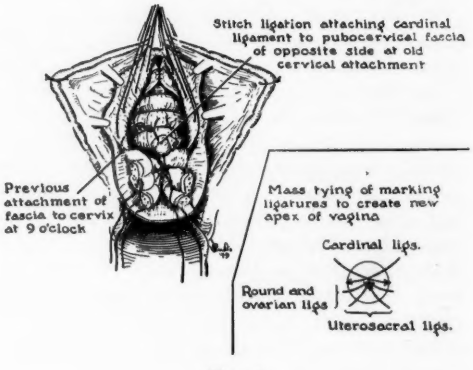
Stitch ligation attaching cardinal ligament to pubocervical fascia of opposite side at old cervical attachment
Previous attachment of fascia to cervix at 9 o'clock
Mass tying of marking ligatures to create new apex of vagina
Cardinal ligs.
Round and ovarian ligs
Uterosacral ligs.

Fig. 16.

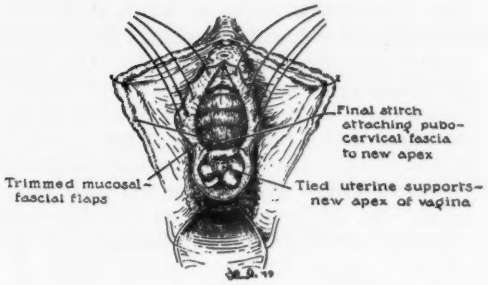
Final stitch attaching pubocervical fascia to new apex
Trimmed mucosal-fascial flaps
Tied uterine supports-new apex of vagina

Fig. 17.

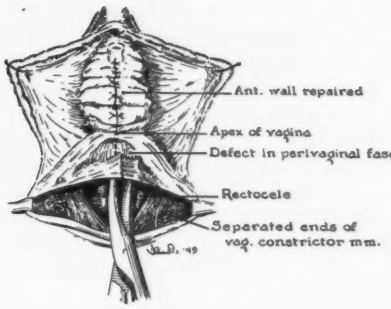


Fig 18.

vaginal vault, it would seem to be a moot point. Actually, the operator very rarely worries about the danger of subsequent prolapse in the modern total abdominal hysterectomy, but since the assembly of these supports is identical by either method, the vaginal operator can and does acquire the same confidence.

2. The danger of too great a bulk of tissue as a result of plication of the cardinal ligaments to the pubocervical fascia of the opposite side. This principle was popularized by Fothergill in writing of Donald's operation for uterine prolapse, now known as the Manchester operation. The step of carrying the ligaments across the midline to shorten them has been a useful and well tried device in this standard procedure for years. In the Manchester operation, the cardinal ligament is continued as a useful structure by reattachment to the side of the cervix opposite to its previous attachment. This principle has been equally of value in this method of supporting the vaginal vault, and at the same time shortening the attenuating cardinal ligaments to raise the height of the vault. With all the other supporting uterine ligaments tied into this arch, the central keystone is maintained. This bulk of tissue heals by first intention in the large majority of patients as evidenced by postoperative observation.

3. The danger of subsequent cystocele, rectocele and/or enterocele. Since the pubocervical fascia is tied into this keystone arch anteriorly, subsequent cystocele is no greater danger than it would be in an abdominal total hysterectomy where the fascia is cut free from the cervix and then reattached to the new vaginal apex. The same reasoning applies to the firm attachment of the rectovaginal septum to the vaginal apex. Enterocele, not feared in the usual abdominal total hysterectomy procedure, is protected against here by careful suture of the uterosacral ligaments into the arch, and then by subsequent attachment of the rectovaginal septum below them, with

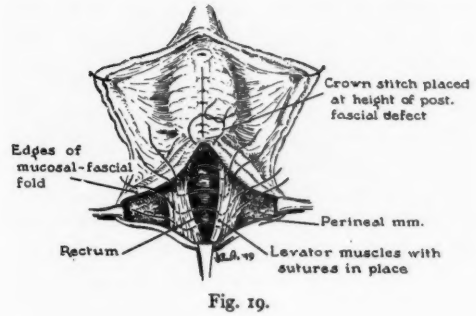
Crown stitch placed at height of post. fascial defect
Edges of mucosal-fascial fold
Perineal mm.
Rectum
Levator muscles with sutures in place

Fig. 19.

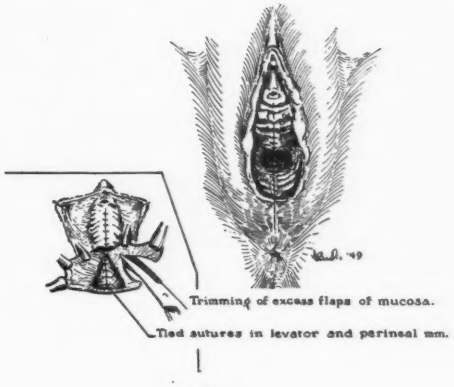


Fig. 20.

additional removal of any excess pouch of Douglas peritoneum. These all are steps which are usually omitted in the abdominal total hysterectomy combined with vaginal plastic procedures.

4. The danger of regarding the pelvic supporting tissue planes as fascial in nature rather than musculofascial. Too often we execute these procedures as if they were hernia-like repairs. Actually, the muscular elements in the supporting ligaments are thought to be of equally great importance. The recent work of Kegel and Smith has demonstrated the excellent results of active resistance exercises for the correction of urethral incontinence and genital relaxation. The addition of these exercises to the postoperative care of these patients has been very satisfying.

## SUMMARY

The final result desired is shown in Figure 3, and literally gives the nulliparous canal. Functional use of the canal has been excellent, in both premenopausal and postmenopausal women. No effort has been made in this discussion to present morcellation of large tumors, the radical operation for corpus cancer and the like. The presentation has aimed at presenting a good, heavy-duty teaching technique for beginning gynecologic surgeons. The more complicated operative problems need individualization. As one improves in his knowledge and technique, the various other excellent procedures in the skilled vaginal surgeon's armamentarium will be selected with judgment. No single operation to date has been complete within itself for all patients.

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# LOCALIZED PARALYTIC ILEUS

## An Early Roentgen Sign in Acute Pancreatitis

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IN the past decade fundamental progress has been made in the diagnosis and treatment of acute pancreatitis. The disease formerly was seldom suspected at the bedside and was diagnosed only by surgical exploration. Acute intestinal obstruction, acute cholecystitis, perforated peptic ulcer, suppurative appendicitis, and generalized peritonitis secondary to a perforated viscus were common preoperative impressions. Today, a serum amylase determination confirms the diagnosis without surgical intervention. This is of paramount importance because the early management of this disease is now generally accepted to be conservative and nonoperative (2, 5). It is important also because the disease apparently occurs much more frequently than was previously suspected. The senior author has observed 10 cases of acute pancreatitis during the past year, whereas in the previous 2 years he made the diagnosis on only 2 occasions. It is the authors' purpose to report a roentgen finding, present on the scout film of the abdomen, which has been of considerable assistance in the early diagnosis of acute pancreatitis.

During the past year we have noted the presence of an isolated, gas-distended loop of small intestine on the scout film of the abdomen in acute pancreatitis. This loop is usually present in the left upper quadrant, but has been seen in other regions of the abdomen as well. It is our belief that this represents a localized paralytic ileus affecting a segment of jejunum or ileum, and is probably caused by contact with escaping pancreatic enzymes, as postulated by Metheney and associates. Whereas the occurrence of generalized paralytic ileus in acute pancreatitis is known (10, 12), localized paralytic ileus affecting an isolated loop of small intestine has not been previously stressed. A similar loop was encountered in cases of acute appendicitis and acute cholecystitis by Levitan, and the distended segment was aptly named by him the "sentinel loop." Reports of 8 cases, in which a sentinel loop was present and in which the diagnosis of acute pancreatitis was confirmed by an elevated serum amylase, follow.

From the Departments of Surgery, Internal Medicine, and Radiology of the Jewish Hospital, Cincinnati, Ohio, and Department of Internal Medicine, College of Medicine, University of Cincinnati.

CASE 1. G. L. (48-5324), an obese, white male dentist, aged 58 years, was admitted to the Jewish Hospital June 18, 1948, in severe shock. The history disclosed that, while at work, he had been taken suddenly ill with severe, cramping pain in the right upper quadrant which spread throughout the abdomen and to the lower and anterior part of the chest. Shock ensued and he lost consciousness. His general health had been good, with the exception that on the previous day he had noted his urine was dark. In 1930, an attack of abdominal pain had been diagnosed as acute cholecystitis.

On physical examination the patient was writhing with pain. His skin was icteric, cold, and clammy. His temperature was 101 degrees F.; pulse 130 and feeble; blood pressure 90/60. Tenderness and rigidity were present in the right upper quadrant of the abdomen. Rhythmic, increased peristaltic rushes were heard in the same region.

Laboratory findings indicated that on admission the red blood count and the hemoglobin were normal. The white blood count was 10,200 with 90 per cent polymorphonuclear leucocytes. The serum amylase was erroneously reported as zero. The following day the white count was 11,200 and the polymorphonuclear leucocytes were 90 per cent. The fasting blood sugar was 133 milligrams per cent. The serum amylase was 2,600 Somogyi units (control, 133 units). The total serum bilirubin was 6.8 milligrams per cent (direct, 2.1 mgm. and indirect, 4.6 mgm.). The cephalin flocculation test was negative at the end of 48 hours, the prothrombin concentration was 80 per cent of normal, and the alkaline phosphatase was 10 Bodansky units. The total serum protein, the albumin globulin ratio, the blood urea nitrogen, the plasma chlorides, and the carbon dioxide combining power were all normal. The urine was positive for bilirubin and urobilinogen. The

Fig. 1. G. L. A hairpin loop of small intestine is seen in the left upper quadrant (arrows).

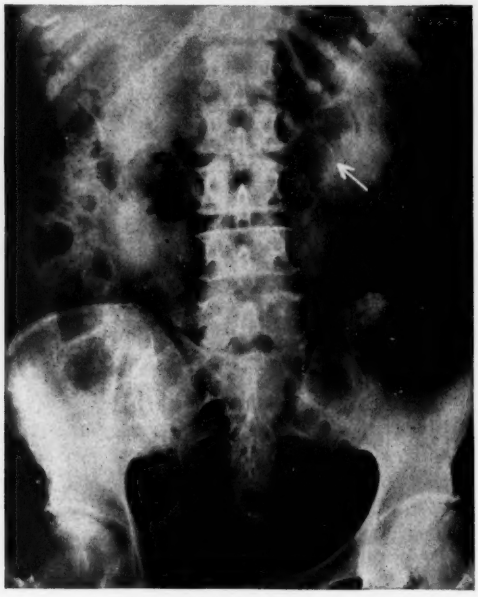

Fig. 2. K. D. An isolated loop of small bowel, with typical "coiled spring" appearance in left upper quadrant.

stool was negative for occult blood and positive for urobilinogen. The electrocardiogram was normal.

Roentgen findings: On admission the flat plate of the abdomen revealed an isolated, dilated loop of small intestine in the left upper quadrant (Fig. 1). The roentgenologist interpreted this as indicating acute mechanical intestinal obstruction. Barium enema was normal.

The clinical picture suggested an acute abdominal catastrophe, most likely acute pancreatitis. Despite the clinical picture, this diagnosis was not tenable in view of a serum amylase report of zero.

Since the precarious condition of the patient precluded exploratory laparotomy, he was treated by means of continuous suction with a Miller-Abbott tube, antibiotics, and symptomatic supportive therapy. On the following morning a second serum amylase determination showed 2,600 Somogyi units, thereby establishing the diagnosis of acute pancreatitis. Cholecystograms on 2 occasions revealed a nonfunctioning gall bladder. On a conservative regimen the patient improved and was discharged on the fifteenth hospital day.

At this time the authors were not familiar with the occurrence of a sentinel loop in acute pancreatitis. This case demonstrated that a gas distended segment of small intestine, simulating the early roentgen findings of acute small bowel obstruction, occurs in acute pancreatitis. The experience gained from the roentgenograms in this case was instrumental in establishing the correct diagnosis in each of the following 2 cases.

CASE 2. K. D. (485633), a white female, aged 58 years, was admitted to the Jewish Hospital June 28, 1948, because of the sudden onset of severe, sharp, epigastric pain associated with nausea and vomiting. The pain spread to both costal margins and then localized in the right upper quadrant of the abdomen.

On physical examination the patient appeared acutely ill. Her temperature was 101.4 degrees F., pulse 120, respiration 20, and blood pressure 140/70. Other physical findings were negative except for the abdomen, which revealed signs of generalized peritonitis.

Laboratory findings showed that on admission the erythrocyte count was 5,600,000 and the hemoglobin 20.2 grams per 100 cubic centimeter (hemoconcentration). The white blood count was 14,050 with a differential count of 95 per cent polymorphonuclear leucocytes. The urinalysis was negative with the exception of the presence of 0.5 per cent sugar. The prothrombin concentration was 55 per cent of normal. The total serum bilirubin was 7.0 milligrams. The urine urobilinogen was 2.8 Ehrlich units. The cephalin flocculation, thymol turbidity, alkaline phosphatase, blood urea nitrogen, and glucose tolerance tests were all normal.

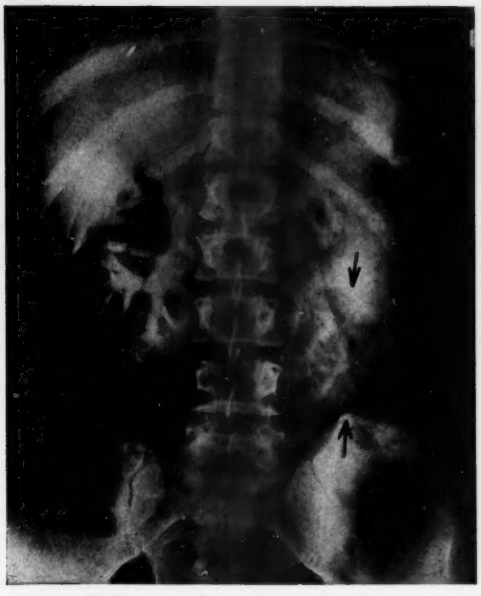

Fig. 3. T. T. A coiled loop of small bowel is seen in the left mid-abdomen.

Fig. 4. E. B. The solitary loop presents the typical "herring bone" appearance of small bowel.

Roentgen findings: The flat plate of the abdomen taken on admission revealed a single dilated loop of small bowel in the left upper quadrant (Fig. 2).

The original diagnosis, made by the family physician, was acute cholecystitis and the patient was treated conservatively. When seen in consultation 48 hours after admission, the abdominal examination revealed signs of generalized peritonitis. A diagnosis of perforated gall bladder was entertained and an exploratory laparotomy recommended. However, when the admission film of the abdomen was reviewed, a single distended loop of small bowel was seen in the left upper quadrant. Because of our previous experience in Case 1, a serum amylase determination was ordered and found to be 3,200 Somogyi units (control, 145 units). The diagnosis of acute pancreatitis was established. The medical treatment was continued and she made an uneventful recovery. Cholecystogram prior to discharge revealed a nonfunctioning gall bladder. The patient was discharged on the sixteenth hospital day.

In Case 2 the clinical picture of generalized peritonitis secondary to a perforated gall bladder was present. The flat plate of the abdomen was originally interpreted as normal but, upon later review of the film, a dilated loop of small bowel was identified in the left upper quadrant. Accordingly, the serum amylase determination was ordered and found elevated. As a result of our experience in Case 1, this patient was saved an unnecessary operation.

CASE 3. T. T. (48-7470), a robust, white male, aged 23 years, was admitted to the Jewish Hospital on August 21, 1948, complaining of abdominal pain and vomiting. He had been awakened at 5 a.m. by a severe, sharp pain in the right upper quadrant

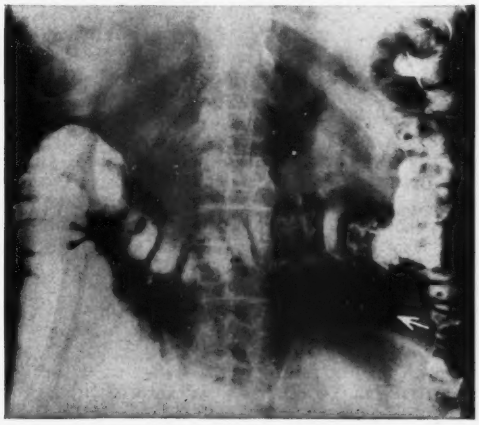

Fig. 5. O. B. A single gas-distended loop is seen in the mid-abdomen. The colon is outlined by barium.

Fig. 6. F. M. K. The isolated dilated small bowel segment seen in the mid-abdomen between stomach and colon.

Fig. 7. M. C. A gas-distended loop of small bowel is present in the mid-abdomen.

which was associated with nausea and vomiting. This was followed by a "cold sweat." The pain increased steadily in severity, and numbness and tingling appeared in the right shoulder and inner aspect of the right upper arm. The previous evening the patient had imbibed a large quantity of beer.

On physical examination the patient was acutely ill and writhing in pain. His temperature was 101 degrees F., pulse 100, and blood pressure 120/80. The only positive findings were tenderness localized to McBurney's point, rebound pain referred to this area, and rigidity in the right upper and lower quadrants.

Laboratory findings showed that on admission the red blood count and the hemoglobin were normal, and the white blood count was 19,200 with a differential count of 84 per cent polymorphonuclear leucocytes. Urinalysis and serology were negative. The prothrombin concentration was 60 per cent of normal. The fasting blood sugar was normal on 2 occasions.

Roentgen findings: The flat plate of the abdomen on admission revealed a single loop of distended small intestine in the left mid-abdomen (Fig. 3).

On the evening of admission a diagnosis of acute appendicitis was entertained. However, when the roentgen findings were noted, a serum amylase was ordered, and showed 800 Somogyi units (control, 160 units), thus establishing the diagnosis. The patient was treated conservatively with intravenous fluids and antibiotics and made an uneventful recovery. He was discharged on the fourth hospital day.

The clinical picture in Case 3 was consistent with a diagnosis of acute appendicitis. However, the finding of a sentinel loop on the flat plate of the abdomen prompted an emergency serum amylase determination which established the diagnosis of acute pancreatitis, and operation was averted.

The following case reports are briefly summarized. The diagnosis of acute pancreatitis was substantiated in each case by the serum amylase test. A sentinel loop was present in each instance.

CASE 4. E. B. (48-6797), a white female, aged 56 years, was admitted to the Jewish Hospital July 31, 1948, with the symptoms and clinical findings of acute intestinal obstruction. The roentgenogram of the abdomen revealed a single distended loop of small intestine in the left upper quadrant which was interpreted as evidence of acute mechanical obstruction (Fig. 4). An exploratory laparotomy was performed but no obstruction was found. The only abnormality noted was the presence of a localized dilated loop of proximal jejunum which was covered with fibrinous exudate. The serum amylase deter-

Fig. 8. E. D. A flat plate made of the abdomen revealed an isolated gas-distended intestinal loop in the mid-abdomen.

Fig. 9. E. D. Barium studies show distended intestinal loop to be lower jejunum or upper ileum (5 hour film). Colon is outlined by barium enema 24 hours previously.

mination was not made until 48 hours after admission and showed a significant elevation, 228 Somogyi units (control, 106 units) (11). The patient made an uneventful recovery and was discharged on the eighteenth hospital day.

CASE 5. O. B. (48-15800), a white male, aged 73 years, was admitted to the Jewish Hospital September 31, 1948, with a clinical diagnosis of intestinal obstruction. The presence of distention of a loop of small bowel on the flat film of the abdomen, prompted the roentgenologist (A. F.) to suggest that a serum amylase determination be obtained (Fig. 5). The result was 1,600 Somogyi units (control, 108 units). He was discharged as recovered 12 days following admission.

CASE 6. F. M. K. (48-10195), a white female, aged 55 years, was admitted to the Jewish Hospital November 8, 1948. A tentative diagnosis of acute cholecystitis was considered on the basis of the history, physical findings, and laboratory studies. Flat plate of the abdomen revealed a sentinel loop of small intestine in the upper abdomen (Fig. 6). The resident surgeon, familiar with this roentgen finding in acute pancreatitis, ordered a serum amylase determination. This showed 800 Somogyi units (control, 110 units). The patient was treated conservatively and discharged, improved, on the eighth hospital day.

CASE 7. M. C., a white female, aged 37 years, was admitted to the Cincinnati General Hospital on June 15, 1949, with a presumptive diagnosis of acute pancreatitis. This was confirmed by a serum amylase determination of 919 Somogyi units. The scout film of the abdomen revealed a sentinel loop in the epigastrium (Fig. 7). On the basis of this finding the roentgenologist, familiar with our work, was able to suggest the correct diagnosis before the serum amylase result was known. The patient was treated conservatively and discharged as improved on the eleventh hospital day.

CASE 8. E. D. (49-6636), a very obese white female, aged 47 years, was admitted to the Jewish Hospital July 13, 1949, with the symptoms and signs of generalized peritonitis. The source of the infection could not be determined. Flat plate of the abdomen revealed an isolated, distended small intestinal loop in the mid-abdomen (Fig. 8). The serum amylase was 8,000 Somogyi units (control, 140 units). Since the general condition of this patient was good, for the purpose of investigation a motility study of the small bowel and a barium enema were performed. It was possible to identify the segment of small intestine as lower jejunum or upper ileum (Fig. 9). (*Barium meal study as a routine procedure in acute pancreatitis is not advised.*) With supportive therapy she made an uneventful recovery and was discharged on the thirteenth hospital day.

## DISCUSSION

The literature contains a number of references to the subject of roentgen findings in

acute pancreatitis (1, 3, 4, 7, 8, 10, 12). In general, these deal with: (1) displacement and distortion of the stomach, duodenum, and transverse colon by the acutely inflamed pancreas; (2) evidence of inflammatory changes in the surrounding soft tissues (psoas muscle and diaphragm); and (3) generalized paralytic ileus. However, we have found no reference to the occurrence of a sentinel loop in this disease.

In our experience the sentinel loop is not an infrequent finding early in the course of acute pancreatitis. Although it is not always present, it occurred in each of the 8 cases reported. Its true incidence can only be determined by study of a larger series of cases.

As previously stated, the appearance of a sentinel loop in other acute abdominal conditions has been reported (9). We have seen 1 instance of localized paralytic ileus associated with acute gangrenous appendicitis. In our experience this finding occurs more frequently in acute pancreatitis than in any other acute abdominal emergency, with the possible exception of acute mechanical obstruction. Localized distention of the small intestine with gas is a common occurrence early in acute mechanical intestinal obstruction (6). Paxton and Payne, impressed by the clinical similarity between intestinal obstruction and acute pancreatitis, recommended that a serum amylase determination be made whenever the cause for the obstruction was not obvious. The importance of this clinical observation is illustrated by Cases 1 and 4.

A serum amylase determination should be obtained whenever a single gas-distended loop of small bowel is encountered on the roentgenogram of the abdomen. By this means one can frequently establish the diagnosis of acute pancreatitis and avoid an unnecessary operation. A greater awareness of the frequency of acute pancreatitis and the more general use of the scout film and of the serum amylase test in acute abdominal emergencies should prove of considerable value in the early diagnosis of this disease.

SUMMARY

1. Eight cases of acute pancreatitis in which an isolated distended loop of small intestine was present on the roentgenogram of the abdomen are reported.

2. This "sentinel loop," simulating small bowel mechanical obstruction, also occurs in other abdominal emergencies. The loop does not occur in all cases of acute pancreatitis.

3. This roentgen sign may be indicative of acute pancreatitis; when encountered, a serum amylase determination should be performed. An unnecessary laparotomy may thereby be avoided.

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# SURGICAL COMPLICATIONS OF CONGENITAL ANOMALIES OF THE UMBILICAL REGION

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MANY cases of congenital abnormalities associated with the umbilicus have been reported. Attention was primarily drawn to these conditions by the work of Thomas S. Cullen, whose book on the embryology, anatomy, and diseases of the umbilicus, published in 1916, is worthy of inclusion in any list of the classics of medicine. Omphalocele and patent omphalomesenteric or vitelline duct are two congenital anomalies of the umbilical region. The surgical complications of rupture of the omphalocele sac and prolapse of the ileum through the patent omphalomesenteric duct will be discussed.

## OMPHALOCELE

Omphalocele, otherwise known as hernia into the umbilical cord, amniotic hernia, or exomphalos, is an unusual congenital anomaly of the umbilical region in which there is a sac at the base of the umbilical cord consisting of a thin, translucent, gelatinous-looking membrane. The sac, varying in size from a few centimeters to as much as 15 centimeters in diameter, contains varying amounts of small intestine, colon, and liver, either singly or in combination, and has a wide communication with the abdominal cavity. The neck of the sac is surrounded by skin, and the line of demarcation between skin and cord is clearly defined. The vessels of the cord course irregularly over the cephalic surface of the sac, to meet together at its apex.

This condition resembles the status of the umbilical region in embryos from the sixth until the end of the ninth week of development, when the midgut, that portion of the alimentary canal from the duodenum to the middle of the transverse colon, lies outside of the walls of the abdominal cavity within the umbilical sac (Mall) (Fig. 1). The failure of the midgut to withdraw into the abdominal cavity has been considered to be due to a disturbance in the relationship of the growth process of the abdominal cavity and that of the abdominal contents, whereby the abdominal viscera remain in the base of the umbilical cord because there is insufficient room for them to return to the abdominal cavity (Bergglas). This does not explain the presence of the liver within the sac which is considered to be related to a faulty development of the supraumbilical portion of the abdominal wall, due either to a failure of union of the mesodermal transverse septum with its amniotic covering, or to a failure in proliferation of embryonal connective tissue in the transverse septum (Margulies).

The incidence of omphalocele has been reported generally to be about 1 to 5,000 births, and a review of the literature does not indicate any hereditary tendency (Jarcho). The largest experience (22 cases) has been reported from the Children's Hospital, Boston (Gross and Blodgett (5)).

The presence of other congenital anomalies is not infrequent, but usually not serious. An associated Meckel's diverticulum is more frequent than its usual incidence; 6 instances were reported in a review of 91 cases of omphalocele found in the literature (O'Leary and Clymer).

There is a definite relation between the time of operation and the operative mortality. This is borne out by Table I (O'Leary and Clymer).

The operative technique has been clearly described by Ladd and Gross (9).

The wall of the sac rapidly undergoes changes. In the first 12 to 24 hours of life the wall is moist, translucent, and pliable. After this time it becomes dried, opaque, and friable, with a tendency to rupture. Such an accident is followed by evisceration and fatal peritonitis (Ladd and Gross, 9). Massabuau and Guibal collected 22 cases of congenital

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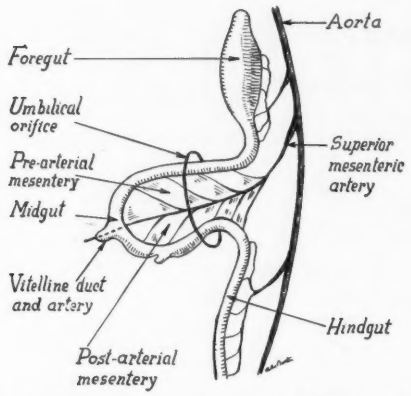


Fig. 1. Diagram representing conditions of primitive alimentary tract at fifth week of fetal life (lateral view). The foregut, midgut, and hindgut are represented with blood supplies in the mesenteries. The midgut loop is large and is extended into the umbilical sac. Redrawn from Ladd and Gross (9). (Courtesy, W. B. Saunders Co.)

umbilical evisceration from the literature up to 1933, and reported 1 case. There were 9 cases in which there was an absence of an amniotic sac, and 14 cases in which the amniotic sac was more or less incomplete around the eviscerated organs. Of the 14 cases with rupture of the amniotic sac, 3 infants were born dead and 3 infants died without operation. However, there were 8 infants who recovered after surgery; operations were performed in 7 cases within the first 12 hours of life, and varying amounts of small and large intestine were eviscerated.

The first cure of a case of omphalocele with rupture of the sac was reported by Visick in 1873, and his graphic description of the case, prior to the era of modern surgery, was as follows:

"I was lately called by a poor Spaniard to see his newly-born child. He told me he believed the midwife had, in dividing the cord, opened the abdomen, and all the bowels had escaped. I found the child tightly enveloped from hips to shoulders with coarse, hard bandages, above which, lying on its neck, and below between the thighs, I could see protruding coils of intestine. On unrolling the child, I found the cord had been divided in the usual place; but that the part next to the skin had been developed into a hernial sac the size of a hen's egg, very thin and transparent and lined with peritoneum, much congested, and communicating with the abdomen by an orifice of the diameter of a cedar pencil. This sac had either ruptured during labor or been opened by the midwife, and the result was that the straining of the child had, besides the original contents of the sac, protruded the cecum and appendix, ascending and transverse colon, and the greater part of the small intestines. They appeared dark and congested; there was a little bleeding from several points, and there was much fluff adhering from the bandages. The greatest possible difficulty was experienced in returning this large mass, from the minute size of the orifice and the violent expulsive efforts of the child; but after more than an hour's patient coaxing, the whole was returned. The orifice in the true skin I secured by an extemporary clamp, and closed with wire sutures. I had afterwards some trouble with a mass of fungous granulations, which I removed by ligature, and the wound then rapidly closed. The child is now five weeks old, and strong and healthy, and has never had a bad symptom. The intestines were exposed just four hours."

TABLE 1.—OPERATIVE MORTALITY IN RELATION TO TIME OF OPERATION IN OMPHALOCELE (O'LEARY AND CLYMER)

| Time | No. of operations | No. of deaths | Operative mortality per cent |
|---|---|---|---|
| To 12 hours | 56 | 12 | 21.4 |
| 12 to 24 hours | 9 | 4 | 44.4 |
| After 24 hours | 13 | 8 | 61.6 |

Hollenberg reported 2 recoveries in infants with omphalocele and rupture of the sac, who were operated upon within 12 hours after birth. One of these infants had an evisceration of the liver and intestine; the presence of well organized fibrin indicated that the rupture had occurred well before the day of delivery.

REPORT OF A CASE

A. H., a male infant, was born at term at the Doctor's Hospital on May 5, 1945. A large omphalocele had ruptured during the delivery. The mass of eviscerated intestines was covered with compresses of isotonic solution of sodium chloride.

On physical examination the infant's temperature was 98.8 degrees F. He was well developed. There were no abnormalities of the head, heart, lungs, extremities, or genitalia.

A large mass of loops of reddened intestine lay on the abdominal wall, coming through a large opening in the sac of an omphalocele. The remainder of the sac was adherent to a round mass of intestine, about 5 centimeters in diameter.

The first operation was performed on May 5, 1945, 2 hours after birth. The exteriorized mass of intestines on the abdominal wall consisted of coils of small intestine and the ascending and transverse

colon. The adherent remains of the sac of the omphalocele were removed from a large, reddened mass of intestine which was found to be attached to the terminal ileum, about 10 centimeters from the ileocecal junction, the usual site of a Meckel's diverticulum. The ileum proximal to the diverticulum was dilated, about 2 centimeters in diameter, and distal to the diverticulum the ileum was collapsed and was about 0.5 centimeter in diameter. The opening in the abdominal wall was about 4 centimeters in diameter.

Excision of the Meckel's diverticulum was necessitated by its large size, preventing its replacement into the peritoneal cavity, by gross inflammation, and the evidence of intestinal obstruction proximal to it. A side-to-side anastomosis was made between the ileum immediately proximal and distal to the Meckel's diverticulum. The anastomosis was effected by using interrupted No. 00000 silk sutures for the seromuscular layers and continuous No. 00000 chromic catgut for the mucous membrane. The Meckel's diverticulum was excised between small Payr clamps. Continuous fine silk sutures were applied over the Payr clamps, the clamps withdrawn and the sutures tied. The exteriorized loops of small and large intestines were liberally washed with isotonic solution of sodium chloride and sprinkled with sulfanilamide powder. A narrow rim of skin of the abdominal wall around the umbilical orifice was excised. The umbilical vessels were ligated with fine silk. The intestines were replaced into the peritoneal cavity. The peritoneum, rectus fascia and skin were closed with mattress sutures of No. 3 silk. The infant's condition was satisfactory at the termination of the operation. A minimum of ether anesthesia was used.

Pathologic report showed that the specimen (Fig. 2) consisted of a sac-like structure, 5 centimeters in diameter, filled with greenish, meconium-like material. The wall of this structure was markedly injected. Segments of small intestine, 3 centimeters and 2 centimeters in length, projected from either side of the sac and communicated freely with it. Another specimen consisted of a segment of umbilical cord, 6 centimeters in length, which had been ligated at one end; the other end terminated in a mass of membranous tissue, 5 by 7 centimeters in diameter. A narrow rim of skin encircled this mass. On microscopic examination the diverticulum and attached segments of intestine showed the four layers of the ileum; portions of the mucosa were hemorrhagic, and an inflammatory exudate of round cells and polymorphonuclear leucocytes was found in the submucosa and serosa.

A transfusion of 90 cubic centimeters of citrated blood and an intravenous infusion of 100 cubic centimeters of 5 per cent dextrose in distilled water and 40 cubic centimeters of isotonic solution of sodium chloride were administered during the day of operation. The infant was kept in an incubator through which oxygen was supplied. An indwelling Levin tube was inserted into the stomach. The highest

Fig. 2. Photograph of the large Meckel's diverticulum found within the ruptured omphalocele.

temperature on that day was 98.8 degrees F. The Levin tube was removed at intervals during the second and third postoperative days and fluids given by mouth, but vomiting of bile-stained fluid followed. The infant's condition was good during this period, and the highest temperature was 100.4 degrees F. on the third day. The intravenous infusion of dextrose solution and isotonic solution of sodium chloride was continued, supplemented by 100 cubic centimeters of blood plasma on the second and third days. A total of 125,000 units of penicillin was administered intravenously during the first 3 days. On the third day urinalysis revealed a trace of albumin and an occasional white blood cell on microscopic examination. The hemoglobin content was 15.2 grams; the red blood cells were 4,200,000; the leucocyte count was 8,000, with segmented polymorphonuclear leucocytes 53 per cent, nonsegmented polymorphonuclear leucocytes 10 per cent, lymphocytes 28 per cent, eosinophils 8 per cent, and monocytes 1 per cent.

The abdomen remained distended and no stools were passed during the first 3 days. A roentgenogram of the abdomen, without the use of a contrast medium, on the third day (Fig. 3), revealed a distended stomach in which the Levin tube was angulated and loops of slightly dilated small intestine; no gas was seen in the large bowel or rectum. Operation was deemed advisable in view of the clinical and roentgenographic evidence of obstruction of the small intestine.

The second operation was performed on May 8, 1945. With the patient under ether anesthesia, a 6 centimeter right rectus muscle-splitting incision was made. There was a small amount of clear fluid in the peritoneal cavity. The loops of small intestine were somewhat dilated; the proximal loops were otherwise of normal appearance, but the wall of the distal loops was reddened, the latter probably being

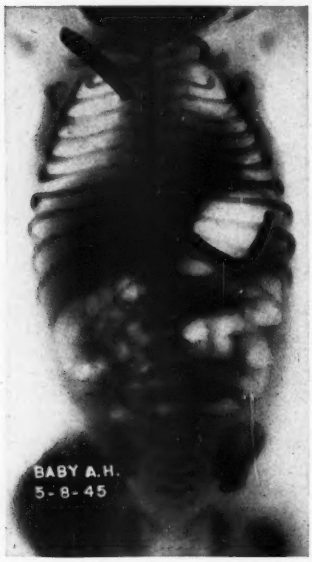


Fig. 3. Roentgenogram of the abdomen (without the use of a contrast medium) taken 3 days after the operation, showing a distended stomach and loops of slightly dilated small intestine; no air is seen in the large bowel or rectum.

Fig. 4. Roentgenogram of the abdomen (without the use of a contrast medium) taken on the patient's discharge from the hospital, showing loops of small intestine and colon and the rectum of normal appearance.

the portion of the small intestine that was exteriorized in the omphalocele. The ileum proximal to the site of the anastomosis was reddened and dilated, and distal to the anastomosis the ileum and colon were collapsed.

The site of anastomosis was excised between small Payr clamps, and the ends of the ileum were closed with continuous fine silk sutures. A side-to-side isoperistaltic anastomosis was made between the proximal loop of ileum and the ascending colon by using interrupted No. 00000 silk sutures for the seromuscular layers and continuous No. 00000 chromic catgut for the mucous membrane. Sulfanilamide powder was scattered in the peritoneal cavity. The abdomen was closed in layers, using a continuous No. 00000 chromic catgut suture for the peritoneum and interrupted No. 00000 silk sutures for the rectus fascia and skin. An intravenous infusion of 60 cubic centimeters of blood plasma was administered throughout the operation.

The pathologic report showed that the specimen consisted of two loops of small intestine, 5 centimeters in length, joined by a side-to-side anastomosis. The surface of the intestine was dull and reddened. The lumen of the intestine at the site of the anastomosis was slightly patent. On microscopic examination the wall of the intestine at the anastomosis appeared somewhat necrotic, and heavily infiltrated with red blood cells and polymorphonuclear leucocytes.

Bacteriologic report indicated that a culture of the peritoneal fluid was sterile.

During the first 4 postoperative days the infant's good condition was maintained by 2 transfusions of citrated blood, totalling 125 cubic centimeters, and blood plasma totalling 260 cubic centimeters, intravenous infusion of dextrose solution and isotonic solution of sodium chloride, gastric siphonage, oxygen therapy and 130,000 units of penicillin. Following this period these measures were discontinued. The highest temperature was 101.2 degrees F. on the first postoperative day. Bloody mucus was passed per rectum 32 hours after operation, and meconium stools on the third day. Feedings of dextrose water were retained on the third day and breast milk on the fourth day, and stools became normal in appearance and number. The weight was 7 pounds 2 ounces on the sixth day. The temperatures were normal after the first week. An additional transfusion of 70 cubic centimeters of citrated blood was administered on the eighth day because of a drop in the hemoglobin content to 10 grams and the red cells to 3,450,000; following this the hemoglobin content rose to 13.5 grams and the red blood cells to 4,450,000. Progress was rapid and the infant was discharged 16 days after the first operation and 13 days after the second, weighing 7 pounds 2 ounces. Roentgenogram of abdomen, without use of a contrast medium (Fig. 4), revealed loops of small intestine and colon and rectum of normal appearance.

Follow-up examination revealed frequent episodes of vomiting of small amounts of feedings and frequent loose bowel movements until the infant was 11 months old. The child progressed well and steadily gained weight. A plain film of the abdomen, taken at the age of 6 months, revealed no abnormality. The child has remained well since infancy. The bowels moved 2 to 3 times a day and were of normal consistency.

At the time of this report, the patient's age is 4 years and 7 months, the weight is 40 pounds, and the height is 42½ inches. Mental and physical development is normal. The abdomen is of normal contour presenting firmly healed wounds in the umbilical and right rectus regions (Fig. 5).

Fig. 5. Photograph of the child at the age of 4 years, showing good nutrition and the operative scars.

### PATENT OMPHALOMESENTERIC DUCT

In the third week of embryonic life the intraembryonic cavity is joined with the extraembryonic yolk sac by the medium of a narrow omphalomesenteric or vitelline duct. As this development takes place simultaneously with the formation of a dorsal mesentery, there results a V-shaped bend in the midgut, continuous with the omphalomesenteric duct at the apex of the V, and suspended from the dorsal wall by a median dorsal mesentery. The duct is accompanied by the omphalomesenteric arteries and veins. The omphalomesenteric duct usually disappears between the fourth and sixth weeks of embryonic life, but its vessels persist long after the duct has disappeared.

Failure of obliteration of the omphalomesenteric duct, or portions of it, results in a variety of anomalies. The most common of these is a Meckel's diverticulum, a sacculation of the ileum which occurs about 2 to 3 feet above the ileocecal valve (Fig. 6). In rare instances the duct is obliterated both at the intestine and at the umbilicus, but the median portion persists with the formation of an intestinal cyst (Fig. 7). In a few cases remnants of the duct have been detected in the umbilical region, manifested by an umbilical polyp (Fig. 8). The omphalomesenteric duct is occasionally found patent at birth (Fig. 9). In this condition some abnormality of the umbilical cord is usually noticed at birth, and when the cord comes away a reddish mass is noted in the umbilicus, in the center of which a small opening can usually be seen, from which some drainage occurs. The amount and character of the drainage are dependent upon the caliber of the duct, varying from clear mucoid material to a fecal drainage. Granulation tissue in the stump of the umbilical cord is not associated with this type of drainage, and disappears after the use of astringents. A superficial remnant of the omphalomesenteric duct may present the same appearance as a patent duct, but it does not communicate with the intestine. The most satisfactory diagnostic procedure in these conditions is roentgen examination after the injection of a radio-opaque material into the opening. The first report of a patent omphalomesenteric duct was by Poussin in 1817. There have been reviews of the literature by Cullen and Morgan. The most recent was by Kittle, Jenkins, and Dragstedt who reviewed 128 cases in the literature, cited an additional case which had been observed elsewhere, and reported 2 additional cases.

The most important and serious complication of a patent omphalomesenteric duct is a prolapse of the intestine externally through the umbilical fistula (Fig. 10), which occurred

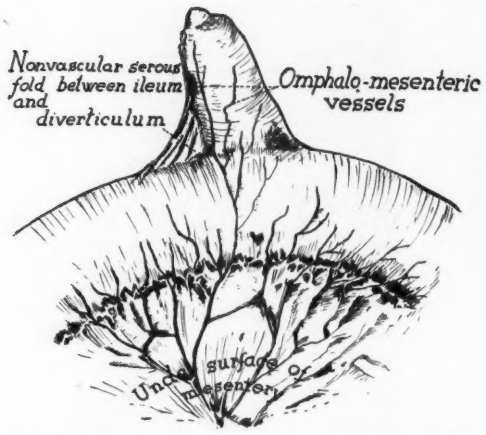


Fig. 6. Diagram of a Meckel's diverticulum ending as a blind pocket. (Redrawn from Cullen (3). Courtesy, W. B. Saunders Co.)

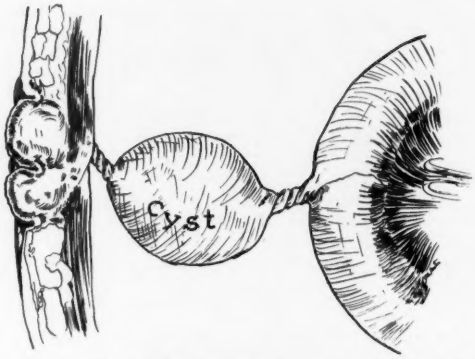


Fig. 7. Diagram of an intestinal cyst, showing the obliterated outer and inner ends of the omphalomesenteric duct and the patent central portion; the accumulation of secretion from the mucosa produces an intestinal cyst. (Redrawn from Cullen (3). Courtesy, W. B. Saunders Co.)

in 28 of the reported cases, an incidence of 20 per cent (Kittle, Jenkins, and Dragstedt). The first report of prolapse of the intestine through a patent omphalomesenteric duct was by Peake in 1811. Prolapse of the intestine occurred any time from 4 hours after birth to 2 years of age, but was most frequent at about 5 months of age. The prolapse was often preceded by an episode of crying or coughing. An abnormality of the umbilicus, described in the discussion of patent omphalomesenteric duct, was noted in the histories of the cases. On examination, a single or T-shaped loop of intestine, prolapsing through the umbilical region, presented on the abdominal wall. The surface of the loop was everted intestinal mucous membrane, dark red in color. The condition was usually associated with some degree of shock. If the infant is seen soon after the onset, it is possible to reduce the prolapse manually. The umbilicus is then excised, the peritoneum opened, and the duct excised to its opening in the ileum. If the resultant defect in the wall of the intestine is small, a closure is performed, but if large, an anastomosis is carried out above and below it after excision of the ileum around the defect. The prolapsed intestine may be quite edematous or necrotic, precluding reduction, in which case excision of the involved parts of the intestine and an anastomosis are performed. The mortality rate has been high, probably because many cases had been reported prior to the era of modern surgery. There have been 3 operative recoveries (Cutler; Kittle, Jenkins and Dragstedt; Bronaugh) in the 29 reported cases, a mortality of 89.6 per cent.

### REPORT OF A CASE

M. S., a girl aged 1 month, was admitted to the Mount Sinai Hospital on October 17, 1945. Since the separation of the umbilical cord ligature, the umbilical region was filled with a reddish mass from which there was intermittent bleeding. A second, small, firm mass protruded from the umbilicus and was attached to it. When the infant was about 2 weeks of age, an additional ligature was tied somewhere in the region of the small protruding mass. Intermittent bleeding continued from the umbilicus. The child was otherwise well until about 9 hours before admission to the hospital when she began to cry a good deal and vomited 3 hours later. The mother noted a profuse, brownish discharge from the umbilicus about 5 hours before admission. Two hours later (3 hours before admission) she noted a long loop of intestine, dark red in color, lying on the abdominal wall.

On physical examination the infant appeared pale and somewhat shocked. The temperature was 98 degrees F. She was small but well developed. There were no abnormalities of the head, heart, lungs, extremities, or genitalia.

A loop of small intestine about 10 centimeters in length, prolapsing through the umbilicus, lay on the abdominal wall ending in the suprapubic region. The surface of the intestine appeared to be everted mucous membrane, dark red in color. There was a small polypoid mass, about 1 centimeter in diam-

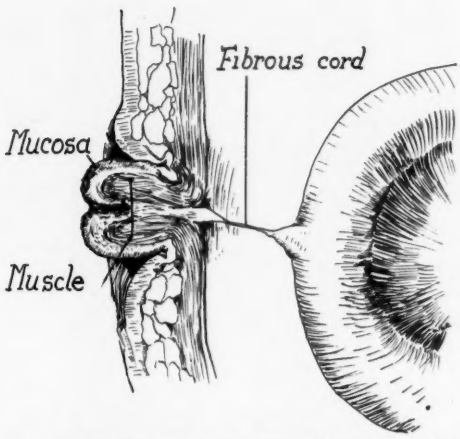


Fig. 8. Diagram of an umbilical polyp, showing the outer end of the omphalomesenteric duct represented by an umbilical polyp, and the intra-abdominal portion by a cord extending from the umbilicus to the convex surface of the ileum. (Redrawn from Cullen (3). Courtesy, W. B. Saunders Co.)

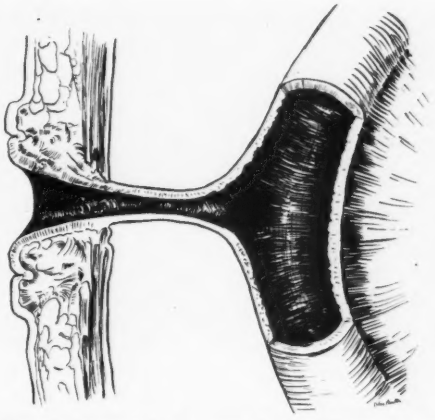

Fig. 9. Diagram of a patent omphalomesenteric duct, showing the lumen of the duct directly continuous with that of the ileum. (Redrawn from Cullen (3). Courtesy, W. B. Saunders Co.)

eter, protruding from the umbilicus alongside the prolapsed bowel.

An intravenous infusion of 5 per cent dextrose in isotonic solution of sodium chloride was started, and the infant was transported to the operating room.

Operation was performed on October 17, 1945. With the patient under ether anesthesia, the abdominal wall was incised above and below the umbilicus by elliptical incisions about 4 centimeters in length. The peritoneal cavity was entered, and a loop of ileum was found to be drawn up to the base of the umbilicus. The prolapsed intestinal loop on the abdominal wall was reduced through an opening in the umbilicus, thus restoring the condition that existed prior to the exstrophy of the ileum. The opening on the antimesenteric surface of the ileum was large and irregular, measuring about 1.5 by 1 centimeter in diameter. Proximal to this site, about 10 centimeters of the ileum was found to be reddened and somewhat dilated; distal to it, the ileum was normal in appearance and was about 4 centimeters in length.

The area of ileum, about 4 centimeters in length, surrounding the opening was excised between small Payr clamps. An additional 10 centimeters of the ileum proximal to the site was then excised because of the appearance of hemorrhagic infarction. Both ends of the ileum were closed with continuous Connell sutures of No. 00000 chromic catgut, covered by continuous sutures of No. 00000 silk through the serosa. A side-to-side isoperistaltic anastomosis between the proximal and distal loops of ileum was made by using interrupted No. 00000 silk sutures for the seromuscular layers and continuous No. 00000 chromic catgut for the mucous membrane. After excision of the umbilical region, the peritoneum and fascia of the abdominal wall in this area were closed with interrupted figure of 8 sutures of silk through both layers. The skin was closed with interrupted sutures of fine silk. A transfusion of 75 cubic centimeters of citrated blood was administered during and immediately after the operation.

The pathological specimen (Fig. 11) consisted of two portions of small intestine. The larger segment,

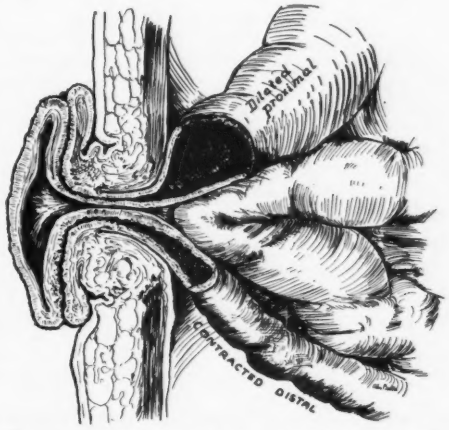


Fig. 10. Diagram of prolapse of the ileum through a patent omphalomesenteric duct, showing a sausage-shaped mass lying on the surface of the abdomen, covered with the mucosa of the ileum; it has an upper and lower opening corresponding to the lumen of the proximal and distal loops. (Redrawn from Cullen (3). Courtesy, W. B. Saunders Co.)

Fig. 11. Photograph of the resected segments of ileum and the umbilical region, showing the extent of ileum involved in the prolapse through the patent omphalomesenteric duct, and the umbilical polyp.

15 centimeters in length, was purplish-red in color. At one end, 1.2 centimeters in diameter, the wall was thickened and the contents were hemorrhagic; at the other end, 7 millimeters in diameter, the everted mucosa was pale. The smaller segment, 8 centimeters in length, showing adhesions on the surface, was hemorrhagic, thickened small intestine with an opening into the umbilicus. A polypoid segment of the bowel wall, 1 centimeter in diameter, close to the umbilicus had a ligature tied around its neck. On microscopic examination both segments of the intestines were found to be portions of the ileum showing early hemorrhagic infarction. The polypoid mass at the site of opening into the umbilicus showed a segment of ileum and acutely inflamed granulation tissue.

An intravenous infusion of 260 cubic centimeters of 5 per cent dextrose in distilled water and isotonic solution of sodium chloride was administered during the day of operation. The infant was kept in a cubicle through which oxygen was supplied. An indwelling Levin tube was inserted into the stomach. Penicillin, 10,000 units every 3 hours by intramuscular injection, was started. The highest temperature on that day was 102.4 degrees F. The hemoglobin content was 59 per cent; the leucocyte count was 13,500, with segmented polymorphonuclear leucocytes 19 per cent, lymphocytes 11 per cent, monocytes 2 per cent and eosinophils 1 per cent.

During the first postoperative day feedings of dextrose water were retained. The infant's good condition was maintained by a transfusion of 60 cubic centimeters of citrated blood and 60 cubic centimeters of plasma, intravenous infusion of dextrose solution and isotonic solution of sodium chloride, gastric siphonage, oxygen therapy, and 80,000 units of penicillin. The highest temperature was 100 degrees F.

During the second postoperative day the infant passed a small amount of bloody mucus per rectum,

Fig. 12. Photograph of the infant taken 15 days after the operation, showing good nutrition and the operative scar.

followed by 3 normal stools. The abdomen was slightly distended. The weight was 7 pounds 9 ounces. The highest temperature was 101.4 degrees F. The hemoglobin content was 61 per cent; the leucocyte count was 14,000, with segmented polymorphonuclear leucocytes 56 per cent, nonsegmented polymorphonuclear leucocytes 13 per cent, lymphocytes 31 per cent, monocytes 9 per cent and eosinophils 1 per cent. A transfusion of 60 cubic centimeters of citrated blood was administered, and the therapeutic measures employed during the first day were continued.

During the third postoperative day the condition was good. The intravenous infusion was continued, and feedings of dextrose water were retained. Oxygen therapy and gastric siphonage were stopped. Penicillin was continued. The temperature was normal. The infant passed one soft stool per rectum. Feedings of an evaporated milk formula were retained on the fourth day. The temperature rose to 102 degrees F. during the fifth day. Stools were normal in number and appearance. The hemoglobin content was 62 per cent. The temperature was normal on the sixth day. The weight 8 pounds 5 ounces. The hemoglobin content was 59 per cent; the leucocyte count was 17,200, with segmented polymorphonuclear leucocytes 45 per cent, nonsegmented polymorphonuclear leucocytes 13 per cent, lymphocytes 39 per cent, monocytes 2 per cent, and eosinophils 1 per cent. Feedings were retained, and the intravenous infusion was discontinued.

During the second postoperative week the infant's condition remained good, she ate well, and the temperatures were normal (Fig. 12). The weight varied between 7 pounds 7 ounces and 8 pounds 4 ounces. There were 1 to 3 normal or soft bowel movements daily. The wound healed by primary union, and the skin sutures were removed on the eighth day. The wounds at the sites of the intravenous infusions were slow in healing. Penicillin was discontinued on the twelfth day, a total of 980,000 units. The hemoglobin content was 75 per cent on the thirteenth day. A roentgenogram of the abdomen, without the use of a control medium, on the thirteenth day revealed a large amount of gas distributed throughout the small intestine and colon; the cecum appeared to be in its normal location.

During the third postoperative week there was a progressive gain in weight. The temperatures and stools remained normal. On the twenty-second day the hemoglobin content was 81 per cent, the leucocyte count 11,200, with segmented polymorphonuclear leucocytes 33 per cent, nonsegmented polymorphonuclear leucocytes 13 per cent, lymphocytes 51 per cent, monocytes 2 per cent and eosinophils 1 per cent. The infant was discharged on the twenty-second postoperative day, weighing 8 pounds 6 ounces.

Follow-up examination, when the child was 7 months old, revealed normal mental and physical development. The weight was 16 pounds 1 ounce. The stools were normal. The wound was firmly healed.

## COMMENT

The successful treatment of ruptured omphalocele and prolapse of the ileum through a patent omphalomesenteric duct is dependent upon early operation, careful operative technique, and adequate preoperative and postoperative management. Even in the era before modern surgery, infants with ruptured omphaloceles recovered when they were operated upon within the first 12 hours of life. It is important that the surgeon be accustomed to the gentle handling of the delicate tissues of the infant and to the use of small instruments and suture materials; these principles of technique are more important than the speed of operation. The measures to be used in preoperative and postoperative care have been outlined in the case reports. The parenteral administration of fluids and transfusions of whole blood or plasma is of the greatest importance; their use during and after operation enabled the infant with a ruptured omphalocele to survive 2 intestinal resections within 3 days. Other useful measures in the management of these infants were: passage of a Levin tube and the maintenance of gastric siphonage (Wangensteen) as long as intestinal or biliary drainage continued, inhalation of oxygen supplied which is through a tent or cubicle, and administration of penicillin.

The surgical complications of omphalocele and patent omphalomesenteric duct can be prevented by immediate repair of the omphalocele in cases in which the sac is not ruptured at birth, and early excision of a patent omphalomesenteric duct.

## SUMMARY

The embryologic, pathologic, and clinical features, and the treatment of the surgical complications of omphalocele and patent omphalomesenteric duct are reviewed.

Recoveries are reported in 1 case of rupture of an omphalocele sac, and in 1 case of prolapse of the ileum through a patent omphalomesenteric duct; the latter is the fourth reported cure of this condition.

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# PNEUMOTHORAX AND MEDIASTINAL EMPHYSEMA COMPLICATING NECK SURGERY

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THE etiology of many cases of respiratory difficulty during operative procedures in the neck will remain unsolved unless the possibility of pneumothorax or mediastinal emphysema is constantly borne in mind. Although these conditions may resolve spontaneously without untoward symptoms in some instances, their potential seriousness warrants prompt recognition in all cases and therapy as indicated in order to avoid prolonged postoperative morbidity and an occasional fatal outcome.

## REVIEW OF LITERATURE

The fact that mediastinal emphysema, subcutaneous emphysema, and pneumothorax may complicate surgery about the head and neck has been known for several decades. In 1884 Champneys described 82 cases of pneumothorax and 5 cases of mediastinal emphysema following tracheostomy[1] in children. A similar series of 9 cases of post-tracheostomy mediastinal emphysema in children was published by Leiner in 1903. The first report of the occurrence of mediastinal emphysema during an operation other than tracheostomy appeared in 1918 when Buford discussed this condition as a complication of thyroidectomy and excision of tuberculous nodes of the neck. In 1934 Keis described a fatal termination in 7 cases of mediastinal emphysema and pneumothorax following thyroidectomy.

Several articles on the same subject have appeared in the more recent medical literature. Death attributable to mediastinal emphysema and bilateral pneumothorax was reported by Ackerman and Bricker in a patient undergoing radical neck dissection. Four of the more comprehensive reviews on the subject were published by Goldberg, Mitchell, and Angrist in 1942, Neffson in 1943, Forbes, Salmon, and Herwig in 1947, and Aisner and Franco in 1949.

A review of the literature indicates that the appearance of mediastinal emphysema with or without an associated pneumothorax is a well recognized complication of tracheostomy in infants and children. Since a comparatively small number of cases have been described in adults it is felt justifiable to report recent experiences with these complications on the head and neck service of Memorial Hospital.

## PATHOLOGICAL ANATOMY AND PHYSIOLOGY

It is a common misconception that pneumothorax complicating surgery about the lower neck is due entirely to accidental injury to the apex of the pleura. Although extensive dissection deep to the scalene muscles in the retrotracheal, paraesophageal area has resulted in the production of homolateral pneumothorax by this mechanism in a few cases, it does not explain the high incidence of bilateral or contralateral pneumothorax encountered in the present series.

In consideration of this problem it is well to review briefly the anatomy of the fascial planes of the neck with special reference to their extension into the mediastinum (Fig. 1).

## ANATOMICAL CONSIDERATIONS

A complete description of the detailed anatomy of the lower neck is beyond the scope of this paper. Important and pertinent, however, are the several layers of cervical fascia:

*Superficial cervical fascia.* This thin, often attenuated fascial layer lies just beneath the skin but superficial to the platysma muscle. It is of no significance in the present discussion.

*Deep cervical fascia.* This dense, smooth fascia is a definite structure which invests the principal organs, vessels, and muscles of the neck. It is not found as a

[1]The term, *tracheostomy* (instead of tracheotomy), is used advisedly. Etymology indicates derivation of the former from the Greek τραχεῖα *trachea* plus στόμα *out-let, mouth*, and of the latter from the Greek τραχεῖα plus τομή *cut, incision*. By analogy with the customary differentiation between colostomy and colotomy, gastrostomy and gastrotomy, etc., we employ the term tracheostomy to indicate an opening into the trachea maintained for several days, and tracheotomy to indicate merely the surgical procedure of incising the trachea.

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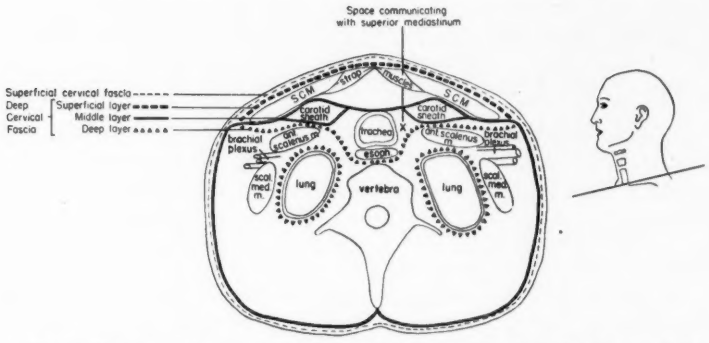



Fig. 1. Diagrammatic representation of fascial layers and principal structures of the lower neck in oblique section as indicated in insert.

single sheet but is divided into several layers whose boundaries and relationships to other structures are as follows:

1. Superficial layer. The superficial layer of the deep cervical fascia lies deep to the platysma muscle and forms the fascial sheath of the infrahyoid muscles, the sternocleidomastoid muscle, and the trapezius muscle. It is attached posteriorly to the ligamentum nuchae and to the spinous process of the seventh cervical vertebra, and is continuous anteriorly with the corresponding superficial layer of deep fascia of the opposite side. Superiorly it is attached to the ramus of the mandible, to the mastoid process and to the superior nuchal line; inferiorly to the periosteum of the sternum, clavicle, and acromial process of the scapula.

2. Middle layer (pretracheal fascia). The middle layer of the deep cervical fascia is attached to the convex anterior surface of the trachea. It extends upward to form the prelaryngeal fascia at which level it is in intimate contact with the posterior aspect of the thyroid gland whose capsule it helps to form. It is attached superiorly to the periosteum of the hyoid bone. It extends laterally to form a complete investment of the great vessels of the neck known as the *carotid sheath*, and continues laterally as the fascial sheath covering the scalene muscles, to end by merging with the fascial covering of the levator scapulae and trapezius muscles. The middle layer extends inferiorly into the mediastinum where it ultimately blends with the fibrous pericardium. *A free passageway into the mediastinum is provided by opening this middle layer of the deep cervical fascia.*

3. Deep layer (prevertebral fascia). The deep layer of the deep cervical fascia passes in front of the prevertebral muscles and is attached to the convex anterior surfaces of the cervical vertebrae. It is adherent superiorly to the base of the skull. Laterally it fuses with the sheaths of the scalene muscles, and ends by merging with the fascial covering of the trapezius, levator scapulae, and erector spinae group of muscles. In its lateral extension the deep layer of the deep cervical fascia splits and forms a dome over the apex of pleura and lung presenting in this area (Sibson's fascia). Inferiorly the prevertebral fascia is continuous in the superior mediastinum with the endothoracic fascia. *Between the middle and deep layers of the deep cervical fascia in the midline space containing the trachea and esophagus there is an open passage into the superior mediastinum.*

Two theories regarding the etiology of pneumothorax and mediastinal emphysema following operation in the neck have appeared in recent medical literature. One postulates the development of pneumothorax by rupture of the mediastinal pleura from increased intramediastinal pressure (i.e. tension pneumomediastinum) secondary to the entrance of air into the mediastinum through a wound in the base of the neck. The other attributes the development of mediastinal emphysema and pneumothorax to pulmonary interstitial emphysema produced by rupture of marginal alveoli. Air under tension in the mediastinum, however it may occur, follows one or more of several paths. It may rupture the mediastinal pleura producing unilateral or bilateral pneumothorax. It may dissect upward into the tissues of the neck, face, axilla, and thoracic wall. It may follow the aorta and esophagus into the retroperitoneal area.

In consideration of the first theory, it is obvious that factors other than the presence of a free passageway into the superior mediastinum must be present to produce a pneumothorax since only a few of the many cases in which the middle layer of the deep cervical fascia is opened actually develop this complication. The most important contributing cause is the

simultaneous existence of partial respiratory obstruction due to excessive coughing, laryngospasm, mucous secretions or other factors related to the anesthesia or physical condition of the patient. The increased intrathoracic negative pressure associated with exaggerated respiratory effort sucks air into the mediastinum through the superior thoracic inlet widened in inspiration. Partial closure of the opening during expiration permits air to accumulate in the mediastinum under tension. When the pressure in the mediastinum has reached a sufficiently high level, the mediastinal pleura ruptures producing with equal readiness a homolateral, contralateral, or bilateral pneumothorax.

The other theory explaining mediastinal emphysema and pneumothorax as a sequel to pulmonary interstitial emphysema postulates the development of the latter as a result of weakening of the marginal perivascular alveolar bases with escape of air from alveoli to vascular sheaths. This may occur clinically in any one of the following situations: (1) partial atelectasis of the lung with hyperinflation of the adjoining regions of the same or opposite lung; (2) increased intra-alveolar pressure during coughing, straining, or positive pressure anesthesia; (3) decreased blood supply to the pulmonary vessels usually associated with increased intra-alveolar pressure or with hyperinflation. Air escaping to the vascular sheaths of the lung follows the path of least resistance and passes toward the hilus and mediastinum. With a continuation of the factors causing the pulmonary interstitial emphysema, air accumulates in the mediastinum under increasing tension, and if rupture of the mediastinal pleura occurs, unilateral or bilateral pneumothorax ensues.

### MEMORIAL HOSPITAL SERIES

*Source of material.* In the past 5 years 18 cases of pneumothorax and 2 cases of mediastinal emphysema have occurred at Memorial Hospital during the course of operative procedures performed about the head and neck. Bilateral pneumothorax was found in 12 cases. Homolateral pneumothorax occurred in 4 patients and contralateral pneumothorax in 2 patients.

Although several of the patients were in poor physical condition prior to operation as a result of cardiovascular, renal, or metabolic complications, only 4 showed evidence of preexisting pulmonary disease in the form of pleural thickening, healed tuberculosis, emphysema, and chronic bronchitis. In no patient was there a history suggestive of previous episodes of pneumothorax or mediastinal emphysema.

*Anesthesia.* Since factors relating to the anesthesia may be instrumental in producing mediastinal emphysema or pneumothorax, the cases in this group were reviewed to determine the existence of any condition that might have produced undue coughing, laryngospasm, or other forms of tracheobronchial obstruction.

The technique of anesthesia described by one of us using a 2.5 per cent solution of sodium pentothal was employed in all patients except the one undergoing emergency tracheostomy. An intratracheal tube was inserted under topical anesthesia in the earlier cases. Intubation under pentothal and dextrotubocurarine chloride replaced topical anesthesia in the group operated upon during the latter part of 1949. In the majority of cases tracheostomy was performed at the end of operation to facilitate postoperative care and to insure an adequate airway after removal of the intratracheal tube.

Difficulty in inserting the intratracheal tube was experienced in 3 patients. In a fourth patient pressure from a mouth pack produced partial obstruction of the intratracheal tube, while in a fifth unexplained interference with the airway in spite of a preliminary tracheostomy necessitated premature division of the trachea during a total laryngectomy. Although specific difficulties with anesthesia were thus encountered in only a few patients, the facts that several were anesthetized by relatively inexperienced residents in anesthesiology and that about half of the group required supplementary medication in the form of intravenous morphine during the course of operation indicate that the anesthesia was not entirely smooth and uneventful in these particular cases.

*Clinical signs and symptoms.* The diagnosis of pneumothorax is frequently difficult to establish during the course of operation since in

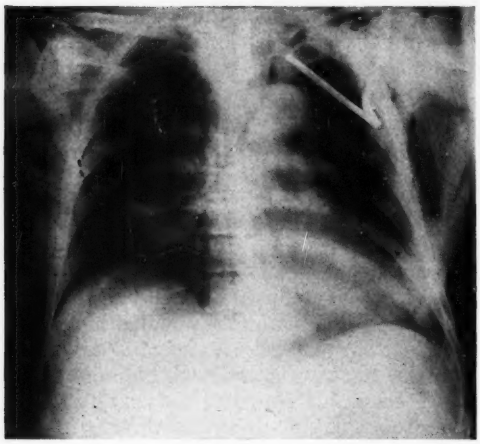


Fig. 2. Portable roentgenogram of patient G. T. F. showing expansion of left lung following catheter decompression of left pleural cavity, but an unsuspected partial right pneumothorax. Extensive soft tissue emphysema delineates the muscle fasciculi of the right pectoralis major muscle.

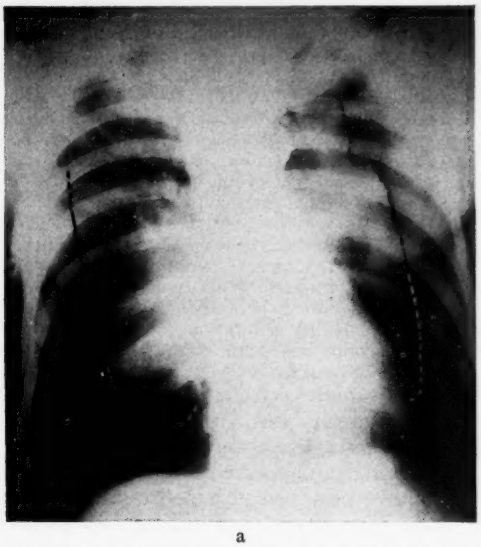
the majority of cases the classical symptoms and physical signs either cannot be elicited or are masked by the anesthesia. The recognition of a pneumothorax during or immediately following surgery depends first of all on awareness of its possible occurrence.

In the present series almost every patient developed some variation in his normal respiratory pattern. The majority showed a labored abdominal type of breathing with a prolonged expiratory phase. The respirations of a few patients were rapid and shallow. In others there was a marked discrepancy between the respiratory effort of the patient and the movements of the breathing bag of the anesthesia machine. Varying degrees of cyanosis occurred at some stage in over half the patients and evidences of circulatory failure (tachycardia, hypotension) were found in a smaller group. The appearance of subcutaneous emphysema either on the operating table or in the immediate postoperative period is the most reliable inferential sign of the presence of pneumothorax or mediastinal emphysema. This was found in about half the cases in the present series. Substernal pain was present in the patient on whom an emergency tracheostomy was performed under infiltration anesthesia. In a few cases auscultation revealed abnormality in breath sounds and inspection of the thorax disclosed differences in motion of the two sides, but these were exceptions to the general rule.

In all cases of pneumothorax symptoms developed gradually during the last half of the operative procedure. Diagnosis was established by roentgenographic examination or by diagnostic thoracentesis. In 2 recent cases respiratory difficulties were noted shortly after the onset of operation and persisted throughout the entire procedure. Both patients subsequently were shown to have mediastinal and subcutaneous emphysema, but no pneumothorax.

*Treatment.* The importance of prompt and adequate therapy for a complicating pneumothorax cannot be overemphasized since experience has shown that failure in this respect may lead to a fatal outcome. In view of the fact that the onset of symptoms is usually insidious, the anesthesiologist and surgeon must constantly bear in mind the possibility that changes in respiration or circulation occurring during the course of head and neck surgery may be due to this complication. The time at which therapy is instituted depends largely on the condition of the patient. Marked respiratory distress and cyanosis require immediate treatment even though the operation must be temporarily interrupted. If the general status of the patient is reasonably satisfactory it is justifiable to wait for x-ray confirmation of the diagnosis.

In the early cases of this series one or more pleural aspirations were usually regarded as sufficient therapy for patients with unilateral or bilateral pneumothorax. Continuous underwater drainage was employed only when repeated aspirations failed to prevent reaccumulation of air in the pleural cavity. Since two of the fatalities in the group can be traced to inadequate therapy, it has now become our practice to institute catheter drainage as soon as a diagnosis of pneumothorax is established. By means of a trocar, a No. 14 French catheter is inserted into the pleural cavity through the third or fourth intercostal space anteriorly and connected to an underwater drainage system. If difficulty is encountered in determining on



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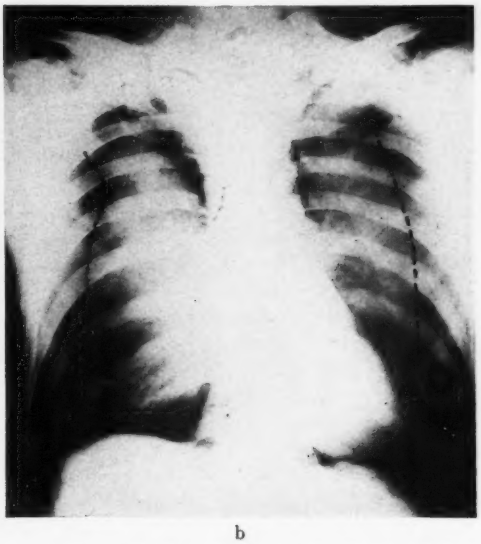

b

Fig. 3. Portable roentgenograms of patient G. F. a, Film taken immediately postoperative, showing bilateral partial pneumothorax. b, Second postoperative day just before death, showing persisting bilateral pneumothorax.

which side the pneumothorax exists, aspiration with subsequent catheter decompression is first performed on the side corresponding to operation. Incomplete relief of symptoms following release of air under pressure from one pleural cavity usually indicates the presence of a bilateral pneumothorax requiring the same therapy on the opposite side (Fig. 2).

One patient in the present series made an uneventful recovery following a unilateral pneumothorax without specific treatment of any kind. In this instance (Case 4) the presence of a contralateral pneumothorax was overlooked on the wet portable chest film, and was not appreciated until review of the film 8 days later, by which time the pneumothorax had resolved. Four patients of the remaining group were treated by aspiration alone and 3 by aspiration followed by unilateral or bilateral underwater drainage. Catheter drainage of one or both pleural cavities was employed as the initial therapy in all the other patients in whom there was a complicating pneumothorax.

In the 2 patients of this series with mediastinal emphysema only, no specific therapy was given. The mediastinal emphysema in each instance resolved spontaneously. It is conceivable, however, that active decompression of the mediastinum might be required in an occasional case in which the mediastinal emphysema is progressive and not associated with a pneumothorax.

*End results.* The efficacy of early and adequate therapy is indicated by the lower morbidity and mortality in the cases of the past 2 years as compared with the earlier cases in this series. Although there was a mortality of 28 per cent in the 18 cases of pneumothorax only two of the fatalities could be attributed directly to the effects of this complication. In the other cases[1] there was no evidence of pneumothorax at the time of death or its degree was so slight at the time of exitus that it could not be considered a major factor in the fatal termination.

The case histories of 2 patients in whom death was due to inadequate treatment of pneumothorax are presented herewith since

[1]Three patients died respectively on the 12th, 8th, and 4th postoperative days. Causes of death were listed as pneumonia, delirium tremens, strangulated hernia and pulmonary edema in 1; pulmonary suppuration following aspiration of tube feedings in another; and bilateral bronchopneumonia and shock in the third. In this last patient roentgenographic examination showed complete re-expansion of one lung with partial pneumothorax still present on the opposite side on the day of death.

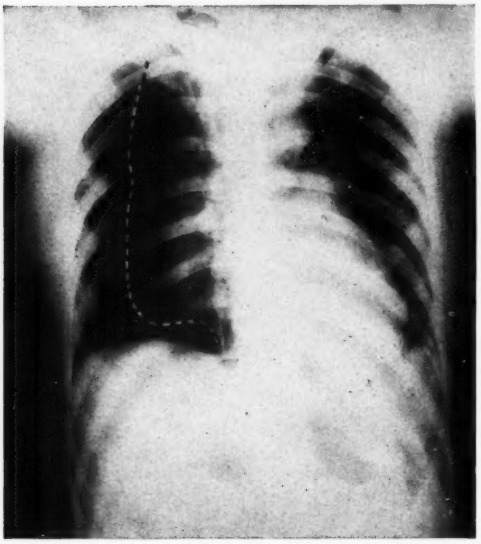

Fig. 4. Portable roentgenogram of patient M. W. showing right pneumothorax and mediastinal shift to the left.

they illustrate the necessity for prompt and adequate therapy when this complication has occurred:

CASE 1. The patient, G. F., was a 40 year old man with Hurthle cell adenocarcinoma of the thyroid. Total thyroidectomy with right radical neck dissection was performed under 2.5 per cent sodium pentothal anesthesia on March 28, 1945. Morphine sulfate 1/6 grain and scopolamine hydrobromide 1/150 grain were given intravenously as supplementary medication during the course of the operation. Delivery of the mediastinal part of the tumor was followed by labored respirations, cyanosis, tachycardia, and temporary elevation of the blood pressure. Subcutaneous emphysema of the neck, thorax, abdomen, and scrotum had appeared by the end of the operation. The patient was in poor condition at this time. Pneumothorax was suspected. Although air was withdrawn from both pleural cavities by aspiration, there was little improvement in the patient's condition. A second aspiration was performed on the first postoperative day followed by catheter drainage of the right pleural cavity. Although respiratory and cardiovascular function was slightly better for the next 12 hours, the patient developed recurrent respiratory distress with signs of cerebral damage and died 36 hours postoperatively. Roentgenograms of the chest on the day of death showed the presence of mediastinal air with a 50 per cent bilateral pneumothorax, indicative of inadequate treatment (Fig. 3).

CASE 3. The patient, M. W., was a 32 year old woman with adenocarcinoma of the thyroid and metastases to cervical nodes. Subtotal thyroidectomy with right radical neck dissection was performed under 2.5 per cent sodium pentothal anesthesia on June 11, 1945. Supplementary medication consisted of intravenous morphine sulfate 1/6 grain and scopolamine hydrobromide 1/150 grain. Upon removal of the mediastinal portion of the tumor respirations became labored, cyanosis appeared, and the general condition of the patient began to deteriorate. Roentgenographic examination of the chest revealed a 50 per cent pneumothorax on the right side with a mediastinal shift to the left (Fig. 4). Aspiration of the pleural cavity produced slight temporary improvement. Six hours after the first aspiration the patient became increasingly cyanotic with rapidly failing respiration and circulation. A repeat aspiration yielded no air[1] and death followed within a brief period.

It is our impression that both these patients would have survived if treatment by underwater catheter decompression had been established during the course of operation. Delay in treatment coupled with inadequate therapy produced irreversible respiratory and circulatory failure.

## DISCUSSION

Only 1 of the 18 cases of pneumothorax in the present series can be directly attributed to accidental opening of the pleural apex. Although pleura was entered on the operative side in 3 other patients, the defect was closed within a brief period after it had been created. In each of these 3 cases pneumothorax was bilateral indicating the existence of causative factors other than the surgical trauma.

Since the existence of pneumothorax in the majority of cases in the present series was not due to surgical injury to the pleural apex, the question remains as to which of the previously described theories can best explain the etiology of this condition. In the other 17 cases of unilateral or bilateral pneumothorax the clinical evidence lends support to the theory of entrance of air into the superior mediastinum through the operative site. It seems unnecessary to postulate rupture of marginal alveoli as the causative factor of pneumomediastinum in these cases. All the operative procedures were such that opening through the middle layer of the deep cervical fascia could not be

[1]Aspiration was performed in the 8th intercostal space in the midaxillary line rather than anteriorly in the 3rd or 4th intercostal space as would be done at the present time. It is probable that the persisting air was trapped anteriorly and superiorly in this particular case.

avoided. Symptoms of respiratory and circulatory distress occurred invariably late in the course of operation, and, in several patients the onset of symptoms could be traced directly to manipulation in the suprasternal and retrosternal areas. Partial obstruction to respiration, due either to anesthesia or to the underlying disease process, was present in a large number of cases. Although the existence of respiratory obstruction in these patients lends support to the theory of pulmonary interstitial emphysema, it equally well supports the theory of tension pneumomediastinum secondary to opening of fascial planes in the lower neck. Respiratory obstruction can cause a high degree of negative pressure not only in the mediastinum but also in the pleural cavities through the resulting exaggerated respiratory motions. An intramediastinal pressure no higher than atmospheric in the presence of an abnormally high negative intrapleural pressure might provide a sufficient pressure gradient to produce rupture of emphysematous blebs on the mediastinal pleura.

On the contrary, the course of events in 2 recent patients who showed only mediastinal and subcutaneous emphysema would seem to illustrate the development of this complication following rupture of marginal alveoli. A brief case history of one of these patients is presented as an example of this mechanism.

CASE 20. The patient, M. D., was a 72 year old man with recurrent cancer of the floor of the mouth and metastases to left cervical nodes. His past history was irrelevant except for an episode 1 year prior to admission of dyspnea and edema of the ankles diagnosed and treated as a probable pulmonary infarct from leg thromboses. Since that time he had had a persistent mucoid bronchitis. Roentgenographic examination of the chest showed increased hilar markings. A left radical neck dissection, resection of the mandible and floor of mouth, and partial glossectomy were performed under 2.5 per cent pentothal anesthesia. The patient was intubated easily with a No. 35 French nasal endotracheal tube after having been anesthetized with pentothal and dextrotubocurarine chloride. A considerable degree of respiratory depression persisted for about 20 minutes after intubation necessitating the use of controlled respiration to insure adequate oxygenation. Although the respiratory exchange improved gradually, the respirations remained abdominal in type with a prolonged expiratory phase. The chest was immobile in the inspiratory position. About an hour after the start of surgery, confined at this time to the upper neck, the respirations became progressively more labored. Moderate cyanosis and tachycardia appeared in the last half hour of operation. Although pneumothorax was suspected the general condition of the patient was sufficiently good to permit roentgenographic examination before institution of therapy. A chest film taken in the operating room showed mediastinal emphysema but no evidence of pneumothorax (Fig. 5). After a tracheostomy had been performed the patient was returned to the ward. During the first 2 hours after operation there was a steady increase in respiratory and circulatory distress. A second chest film taken at this time revealed a decrease in the mediastinal emphysema and the appearance of subcutaneous emphysema in the soft tissues of the neck. The patient's general condition then started to improve within a short time and he made an uneventful recovery.

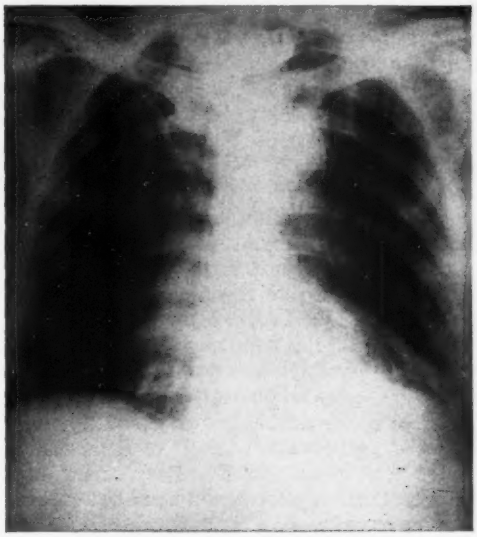

Fig. 5. Portable roentgenogram of patient M. D. showing well expanded lungs bilaterally but marked mediastinal emphysema. The layering of air in mediastinal tissues is well demonstrated just below the aortic prominence.

It is our impression that the positive pressure employed during the period of compensated respiration in this case produced rupture of marginal alveoli with resultant pulmonary interstitial emphysema and mediastinal emphysema. The tracheostomy wound may have facilitated escape of air into the neck with relief of mediastinal pressure.

The second case of mediastinal emphysema was similar in that symptoms of respiratory

distress were present from the beginning of operation before dissection had been carried into the lower neck.

Two common practices in the treatment of surgical pneumothorax require re-evaluation in the light of this discussion. The first is that of airtight sealing of the wound when a pneumothorax is encountered. Although this form of therapy may be important in the management of sucking wounds of the chest wall, the present series indicates that surgical closure of the neck incision combined with catheter drainage of the involved pleural cavity provides adequate treatment for tension pneumothorax resulting from the entrance of air through the fascial planes of the neck. On the other hand, if pulmonary interstitial emphysema is the causative factor, airtight sealing of the neck incisions is obviously irrelevant.

The other common practice is that of employing oxygen under positive pressure to support a patient with a pneumothorax. While positive pressure is indicated in the treatment of an open pneumothorax to reinflate the collapsed lung, it only adds to the respiratory embarrassment in any case of tension pneumothorax and further increases the complication in those patients in whom rupture of marginal alveoli proves to be the precipitating factor.

## SUMMARY

In the foregoing paragraphs it has been stressed that pneumothorax presents a serious and not too uncommon hazard to surgery in the lower neck. Suspicion of its presence, when a patient under anesthesia shows evidence of respiratory distress with or without cyanosis, variations in blood pressure and pulse, subcutaneous emphysema, or lag in respiratory excursion, is the keynote to its prompt recognition. Diagnosis is then established either by aspiration of the pleural cavity or by immediate roentgenographic examination of the chest.

It is unlikely that surgical injury to the pleural apex in the neck is the usual cause of this complication. The development of pulmonary interstitial emphysema from a partially obstructed airway or from positive pressure anesthesia may on occasion result in mediastinal emphysema and pneumothorax. However, on the basis of the cases herein analyzed, it appears that a tension pneumomediastinum caused by exaggerated respiratory effort and a partially open superior thoracic inlet leads to rupture of the mediastinal pleura and pneumothorax in the majority of cases.

Prompt and adequate treatment of a complicating pneumothorax is mandatory. In this series of cases there have been no complications from the use of water-sealed intercostal catheter drainage. In general in the treatment of postsurgical pneumothorax this method, rather than that of repeated aspirations, is favored because of its simplicity, its effectiveness, and its apparent safety.

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# CYSTIC HEMANGIOBLASTOMAS OF THE CEREBELLUM

## End Results in 25 Verified Cases

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A STUDY of the surgical treatment of cystic hemangioblastomas of the cerebellum from the time when they first began to be recognized and treated palliatively up to the present era when treatment can almost always be definitive and permanently curative offers a remarkably accurate and dramatic account of the great developments in modern neurosurgery and brings into sharp contrast the frustration and despair of the early efforts concerned with the attempted removal of brain tumors.

### HISTORICAL NOTES

In the *Medical Times and Gazette* of 1872 Hughlings Jackson reported the case of a 20 year old girl who suffered with failing vision for 3 months. She had a sister who after two previous "fits" died in the third. The patient suffered a head injury 7 years before she came under observation. Physical examination revealed "double optic neuritis." No ataxia or nystagmus was noted. The patient became totally blind after a period of observation and died suddenly. At autopsy a cyst measuring 1 inch by 1½ inches was found in the right cerebellar lobe. The cyst contained clear yellow fluid and a tumor described as angiomatous and the size of a shilling was found in the outer wall.

Included in this brief report are many of the outstanding characteristics of this disease. The patient was a girl in her third decade whose vision became impaired. The family history was suggestive of other members who had intracranial angiomatous malformations, and a head injury preceding symptoms may have had some etiologic significance. Bilateral papilledema is a frequent finding in this as in other types of brain tumor.

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According to Jackson the "most striking clinical feature was the remarkable intermission of the symptoms." This observation was repeated much later by Cushing, Dandy, and others and is confirmed in this series.

The tragic ending of Hughlings Jackson's patient, however, is now the great exception rather than the monotonously repeated inevitable fate of those who harbored these lesions before the middle 1920's.

Since 1926 when Lindau called attention to the association of cerebellar hemangiomas with angioma of the retina and cysts in other organs of the body this association has been generally recognized. Several early case reports of these multiple lesions are of interest. In 1884 P. H. Pye-Smith reported the case of a 27 year old policeman who, after a course similar to that of Hughlings Jackson's patient, came to autopsy, at which a "simple cyst of the cerebellum" was found in the left hemisphere. The cyst was the "size of a billiard ball." The lateral ventricles were dilated. Cysts were found, too, in the kidneys and pancreas.

In 1888 F. Charlewood Turner reported the case of a 44 year old man who had been hit on the head by a brick about 6 years before the onset of typical cerebellar signs and acute symptoms of a posterior fossa tumor. At autopsy a large cyst of the right cerebellar hemisphere was disclosed. In the wall of the cyst a dark brown mural nodule was found. In addition there was a cyst in the right adrenal gland. Microscopically the cerebellar nodule was seen to be a "highly vascular growth."

In some instances cerebellar hemangiomas are associated with a similar lesion in the spinal cord. Wersilow, in 1913, described a typical case of cystic hemangioblastoma of the cerebellum associated with syrinx of the

cervical cord and, in his article, theorized on the common embryologic origin of these two. In the same year, Koch, in studying pancreatic pathology, reported a typical case of what was later to be called Lindau's disease. In this patient were seen two hemangioblastomas of the cerebellum—one in either lateral lobe, one cystic—cysts of the pancreas, kidney, and a hemangioblastoma of the spinal cord.

The relationship of angiomatous malformations of the central nervous system with such conditions as syringomyelia and rachischisis as embryologic and genealogic defects has been discussed by many workers. Roulet remarked, "It is striking that the angiomas of the rhombencephalon are almost always localized to the line of closure of the medullary tube and that there is a quite frequent association of medullary angiomata with syringomyelia." This statement has often been corroborated. Levin emphasized that in each of 10 spinal cords that were examined of the 16 cases of multiple angiomatosis of the central nervous system that he collected, abnormalities such as cysts, syrinxes, or true vascular tumors were found.

It has long been recognized by neurosurgeons that in some patients a cerebellar cyst may be disclosed at operation, but only after an extensive and extremely careful search has the minute nodule of hemangioma been identified in the cyst wall. This type of lesion was recognized in 1892 by Williamson, who, in reporting on serous cysts of the cerebellum, remarked quite accurately that "until a most careful and minute microscopical examination of every part of the cyst wall has been made, one is not justified in excluding tumor." He presented the case of a 27 year old man who after a course that is now recognized as typical came to autopsy at which a large 2 inch by 1¼ inch cavity was found in the right cerebellar hemisphere. There was "no distinct and separate cyst wall." There was a small "very vascular glioma" in the wall of the cavity. The glioma was composed of "dilated blood vessels." This tumor was undoubtedly a hemangioblastoma. After a brief discussion of the utter failure to that date of all attempts to remove cerebellar tumors Williamson cautiously recommended aspiration of these cysts "after the failure of medical treatment."

### FAMILIAL INCIDENCE

In addition to the features mentioned, the familial tendency of hemangiomas is an interesting point with which we are now quite familiar. The occurrence of angiomatous malformations—von Hippel's disease, Lindau's disease, and so forth—as a hereditary characteristic has been noted by many workers from the first case of Jackson to Rochat, who followed clinically a family in which the grandmother died of "cerebral tumor," two sons had von Hippel's disease, one with a cyst of the cerebellum, and a grandson, who at the age of 16 was noted to have bilateral angiomatosis retinae. Another early example of this tendency was given by Seidel, who in 1912 (quoted by Kufs), reported the case of two brothers, tightrope walkers, each of whom developed symptoms and signs of increased intracranial pressure following falls from a rope. The first had an angioma of the retina without visual difficulty and had a cerebellar cyst evacuated on 3 occasions, with relief of symptoms each time. The second died after his cerebellar cyst was attacked surgically. Moller also reported a family, the members of which were afflicted quite similarly with a group of angiomatous malformations. Thoemsen is quoted by Moller as being the one who demonstrated the transmission of these angiomatous malformations by a simple nonsex-linked, dominant factor. G. Norlen, reporting from the neurosurgical clinic of Olivecrona on the familial occurrence of cerebellar angiomas, by which he obviously means hemangioblastomas, reported 42 cases, in only one pair of which was there a positive familial history. Also remarkable in his series was the complete absence of a single case of angiomatosis retinae. He found of interest, too, what is borne out in our cases which are familial, that there is an obvious tendency of the younger generations to acquire active symptoms of the disease at an earlier age. In 1940 A. E. MacDonald collected from his own experience and the literature 10 cases of Lindau's disease and reported that in two generations of two families 6 cases of Lindau's dis-

ease were found among 11 members. He made the interesting point that the possibility of angiomatosis retinae as a cause of blindness in the second and third decades must be borne in mind even though secondary glaucoma or hemorrhage may obscure the diagnosis. Patterson and Anderson reported another family in which the father and two sons were afflicted with angioblastic tumors; the father and one son had cystic cerebellar tumors and the other son had a parasaggital angioblastic meningioma.

These authors re-emphasize the similarity in microscopic appearance of the angioblastic meningioma and the cerebellar hemangioblastoma. This point was first discussed by P. Bailey, Cushing, and Eisenhardt and more recently by O. T. Bailey and Ford, and by Corridini and Browder.

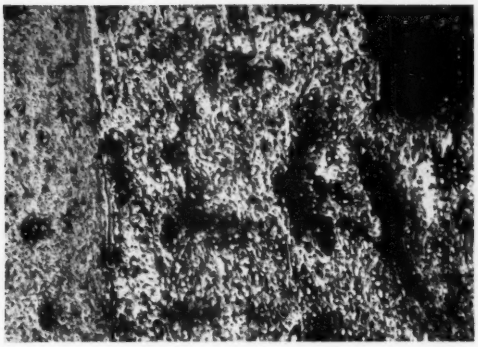
### PATHOLOGIC FEATURES

Following the early inauspicious introduction to the clinical course of patients suffering with this sort of tumor, the pathologic studies of Lindau, reported in 1926, drew wide attention to the frequent association of these cerebellar tumors with von Hippel's disease which can be diagnosed ophthalmoscopically. Twenty per cent, Lindau stated, of all cases of angiomatosis retinae have associated intracranial complications such as cystic hemangioblastomas of the cerebellum, and angiomatous tumors of the medulla and pons. His case reports are of 16 individuals 21 to 50 years of age, averaging 37 years, all of whom died of increased intracranial pressure due to cystic hemangioblastomas of the cerebellum. In many of Lindau's patients the cerebellar tumors were associated with pancreatic and renal cysts or with ovarian adenomas and hypernephromas. These associations strongly supported the theory of the embryologic origin of the growths in question which he and most others believe to be enclosures of embryonic mesodermal angioblastic elements within the neuraxis during the period of the third fetal month.

There was no instance of associated retinal angiomatosis in the series reported by Loyal Davis, and in none of the 42 cases reported by Norlen from Olivecrona's clinic was von Hippel's disease present. Corridini and Browder reported 7 cases of this type of tumor in none of which was angiomatosis retinae found while in all 4 cases reported by Craig, Wagener and Kernohan associated retinal angiomas were present. In Dandy's series of 7, no retinal angiomas were observed. In Cushing's series the active search for these retinal angiomas began too late to obtain an accurate percentage but in 1 case, at least, a retinal angioma was seen. In the series of 25 cases which forms the present report von Hippel's disease was present in 4 patients, or 16 per cent.

The usually accepted pathologic conception of the cerebellar hemangioblastomas is that of Cushing, Lindau, and others. They believed these growths to be embryologic rests, benign in character microscopically, but causing symptoms when their increasing size became sufficient to block the circulation of the cerebrospinal fluid. The histologic characteristics of hemangioblastomas have been described by Lindau and by Cushing and Bailey (6, 7), and others. Cushing and Bailey were particularly insistent on the difference between the hemangiomas and the hemangioblastomas. The former were found seven times more frequently in the cerebrum than in the cerebellum and the angioblastomas were found nowhere outside the cerebellum, according to these authors. They considered the hemangiomas to be merely collections of abnormally located, abnormally formed, and usually abnormally large blood vessels separated and surrounded by glial elements and brain substance, while the angioblastomas they believed to be distinctly demarcated tumors of mesodermal origin only, and containing no ectodermal elements.

The angioblastomas are described by these authors as of three types: (1) predominantly cellular; (2) predominantly capillary; and (3) predominantly cavernous. Between the blood vessels in the more canalized types are cords of pseudoxanthomatous or swollen endothelial cells with abundant granulated cytoplasm. The capillaries are separated by these cells and by reticular fibers, not glial fibers. These reticular fibers are well demonstrated by Perdrau's or Mallory's stain.



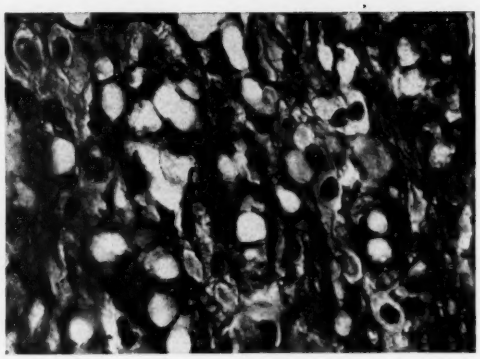


Fig. 1. Case 1. a, left, Low power magnification to show general aspect of tumor with cord-like arrangement of cells. Hematoxylin and eosin stain. ×65. b, right, High power photomicrograph to show character of plump, fat-filled cells with uniform nuclei. Hematoxylin and eosin stain. ×425.

According to Lindau, the four chief characteristics of these tumors are: (1) relative smallness of the tumor nodule in relation to the cyst; (2) location—laterally and posteriorly in the cerebellum; (3) sharply demarcated tumor border—no cyst wall; and (4) microscopic picture similar to that described by Cushing and Bailey.

In respect to the first of Lindau's criteria, while this relationship between solid tumor and cyst is doubtless the usual one, nevertheless there were several instances in our series in which the solid growth was of large size and the cyst relatively small. The same was true in a number of the patients reported by Cushing and Bailey in some of whom a huge solid tumor, only, was present.[1] Again, Lindau's second point concerning the location of the cysts is undoubtedly true, on the whole, but on the other hand many tumors occupying a midline position have been recorded. There were 3 such tumors among our patients.

In all of the available literature we have found only one example of a so-called "malignant cystic hemangioblastoma of the cerebellum," namely, the case reported by Morrison and Gollerkeri. This tumor, because of the differences in characteristics both grossly and microscopically between it and those of Cushing and Lindau, is probably, as the authors themselves admit, of a sarcomatous nature.

[1]We have also had several examples of solid hemangioblastomas of the cerebellum, but the present report concerns only the ones with associated cysts.

The method of formation of the cysts in hemangioblastomas has been a subject of debate ever since they were first described. Lindau, Cushing and Bailey, Roussy and Oberling, and Roulet and others favor the idea that cystic areas occur as the result of an intrinsic process within the tumor such as small lymph and plasma exudations, and breakdown of some of the large phagocytic pseudoxanthomatous cells. Cushing and Bailey early noted the similarity of the constituents of cyst fluid of those of plasma. These observers also remarked on the speed of refilling of these cysts if they were aspirated only, the tumor nodule being undisturbed. The British school, on the other hand, Sargent and Greenfield, Hughlings Jackson and others, persistently relate the onset of symptoms and probably cyst formation with trauma to the head. They quote numerous case histories to support their view and emphasize the relatively late onset of symptoms associated with trauma in spite of the embryologic origin of the tumor. If the English theory is accepted, it seems quite probable that the cranial trauma may cause a hemorrhage from the extremely friable vessels composing the hemangioblastoma, and that the subsequent resolution of the hemorrhage may result in cyst formation.

### SURGICAL TREATMENT

As mentioned previously, the surgical treatment of cerebellar hemangioblastomas has advanced *pari passu* with the development of

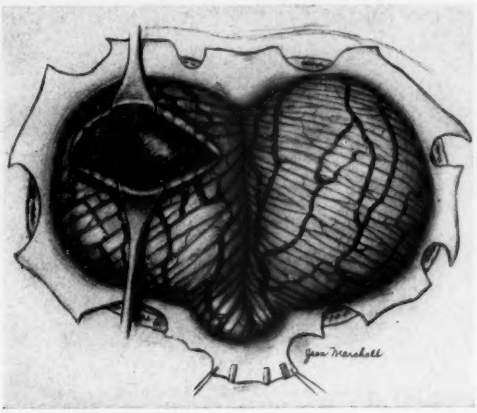


Fig. 2. Case 2. Sketch of tumor at operation. Cyst of left cerebellar hemisphere containing small, characteristic mural nodule of solid tumor.

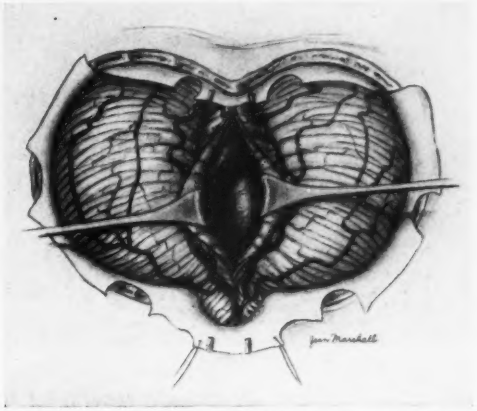


Fig. 3. Case 3. Operative sketch of tumor. In this case there was a median line cyst of vermis with mural tumor on left lateral wall.

modern neurosurgery. When such cysts were first encountered at operation they were aspirated and a decompression of the cerebellum performed. Sargent and Greenfield reported instances in which repeated aspirations were followed by temporary relief of symptoms.

The next step in their treatment was the attempt to destroy the supposed secreting inner surface of the cyst wall by sclerosing agents such as formaldehyde solution and Zenker's fluid. So far as we are aware this method was first used by Cushing, probably between the years 1910 and 1915.

Beginning in 1922 Cushing removed successfully the solid portion of many cerebellar hemangioblastomas and even long before this, in 1908 he had encountered and completely removed one such solid tumor as recorded in his monograph on blood vessel tumors of the brain.

With the advent of electrosurgery in 1928 the complete extirpation of cerebellar hemangioblastomas—both the small mural nodules and the large solid tumors—has become practically a routine procedure with all neurosurgeons, although at times the operation may be fraught with such difficulty from hemorrhage as to tax the ingenuity of the most experienced operators.

In his monograph on 2,000 verified intracranial tumors Cushing reported 25 cerebellar hemangioblastomas of which one was proved at autopsy without preceding operation. This type of tumor, therefore, represented 1.25 per cent of his entire series. What percentage of these was cystic is not stated. Many of his patients had more than 1 operation, and 4 underwent 4 procedures each. His 24 patients were operated upon 44 times. He lists 6 fatalities, a mortality rate of 25 per cent, but of the last 7 patients, operated on 10 times, only 1 died. In the single case in Cushing's series (Case 19, F.McA.) which was associated with angiomatosis of the retina also there was a family history that suggested the presence of similar angiomatous malformations in siblings. This man was subsequently reoperated on by Dr. Cushing, and a third time as Case 5 of this series. We have likewise operated upon this patient's daughter and a grandson with removal of hemangiomatous cysts of the cerebellum. The daughter had only the cystic hemangioblastoma of the cerebellum while the grandson had a similar tumor as well as angiomatosis retinae.

The only other reported large series of cerebellar hemangioblastomas coming to operation is that of Davis in which there were 22 patients having this type of lesion. Of these, 5 died in the hospital following operation and 2 died in the hospital without operation—an operative mortality of 22.7 per cent. Dandy in 1928 reported 7 cases of angiomatous cysts of the cerebellum in 5 of which the

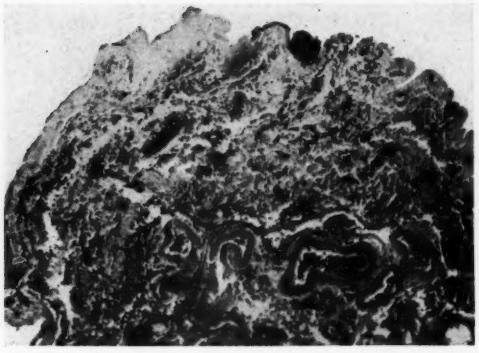


Fig. 4. Case 3. Low power field to show general characteristics of tumor with closely packed tangle of blood vessels, arterial, venous, and capillary. Cellular elements inconspicuous except hyalinized adventitial and connective tissue cells. Phosphotungstic acid and hematoxylin. ×65.

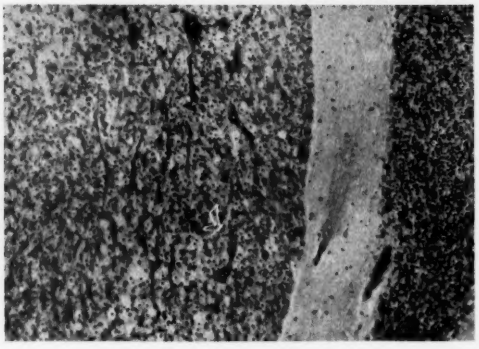


Fig. 5. Characteristic low power field typical of the majority of the tumors in this series showing the cord-like arrangement of the cells. Hematoxylin and eosin. ×65.

nodule and cyst were excised in entirety. These patients were, at his last writing, living and well. He remarked that with signs and symptoms of a "cerebellar tumor appearing in a patient between the ages of 25 and 40, symptoms rapidly progressive (less than 1 year) with variations in them from time to time and the absence of profound disturbances of a primary lesion of the brain stem, a cyst, angiomatous or gliomatous (in the cerebellum) should be suspected."

### DISCUSSION OF PERSONAL SERIES

During the years 1933 to April 1948 there have been 25 cases of cystic hemangioblastoma of the cerebellum treated surgically at the Lahey Clinic. During the same period an approximate total of 1,300 brain tumors have been verified. Cystic hemangioblastomas of the cerebellum, therefore, represent practically 2 per cent of all brain tumors in our series. The patients ranged in age from 17 to 55 at the time of onset of their acute symptoms. The average age was 34.1 years which is quite similar to Lindau's figure. Ten patients were male and 15 female.

In two families in our series the condition was present in subsequent generations.[1] In one the mother and two daughters were affected by angiomatous tumors of the central nervous system, and in the other, three generations were involved. Four of our 25 patients were observed to have angiomas of the retina. This is 16 per cent, closely approximating Lindau's figure of 20 per cent of all patients with angiomatosis retinae who had central nervous system angiomas.

The majority of the patients in this series were affected symptomatically by increased intracranial pressure and cerebellar dysfunction and showed objective signs of these features. Despite marked evidence of the former as measured by papilledema which occurred in 14 of the 25 cases, or 56 per cent, the mental state of the patients on admission was in general "alert." This may bear some relationship to the probable intermittency of the obstructive hydrocephalus. The average duration of symptoms before admission was 10 months, ranging from 3 weeks to over 7 years.

In 5 cases a history of injury to the head previous to the occurrence of acute symptomatology was considered of possible etiologic significance. A good example of such an instance is illustrated by the following case report.

CASE 1. W. C., a 17 year old male, was admitted to the New England Baptist Hospital on April 3, 1945. He had had spells of nausea and vomiting since early childhood, but during the past 3 or 4 months these had been present every morning. Five weeks previous to admission he had been struck on the back of his neck by another boy's hand and the next day he complained of occipital headaches which persisted to the time of admission. His headache

[1]These patients are being made the subjects of separate reports.

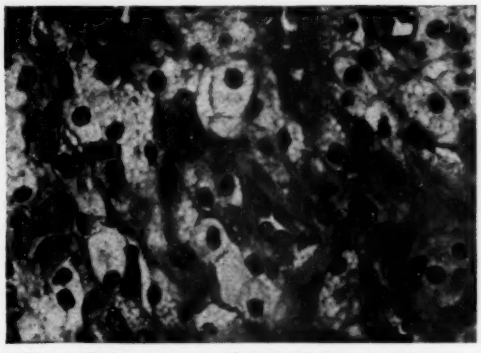


Fig. 6. High power magnification of characteristic tumor to show pseudoxanthomatous cells. Hematoxylin and eosin. ×425.

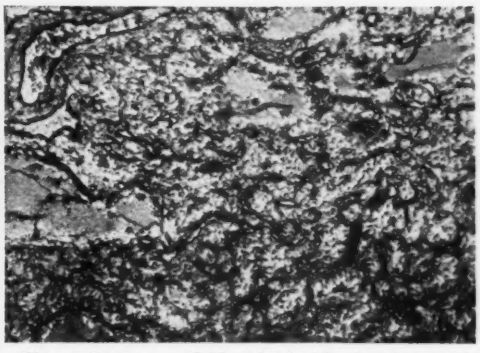


Fig. 7. Low power field stained with phosphotungstic acid and hematoxylin to bring out connective tissue reticulum. ×65.

was increased by flexing his head to the left. During the same period he had noted unsteadiness in walking and diplopia had been present for the past 2 weeks. Neurologic examination disclosed bilateral choked discs of 2 to 3 diopters, bilateral abducens weakness and a nonpersistent nystagmus to the left. There was hypesthesia and hypalgesia of the left face. His gait was unsteady, especially in turning.

Operation was performed on April 5, 1945. A suboccipital craniotomy disclosed a large cyst occupying a considerable portion of the left cerebellar hemisphere. The fluid was evacuated and a small bright red solid nodule was removed from the posterolateral wall of the cyst.

Pathologic report showed that the tumor was composed of small capillary blood vessels lined by endothelial cells and interspersed with numerous plump fat-filled mononuclear cells. There was very little connective tissue stroma. The nuclei of the cells was fairly uniform and showed rare mitoses. The diagnosis was hemangioma (Fig. 1 a and b).

At follow-up 2 years after operation the patient was in excellent condition.

While no clear-cut evidence of the association between trauma and the onset of acute headaches can be shown in this or in other similar cases, nevertheless it is a factor which has been dwelt upon by others as noted previously. Furthermore, in the present instance the trauma was almost directly over the site of the intracranial lesion.

In at least 3 patients the history of episodes of vomiting for years preceding the onset of acute symptoms of increased intracranial pressure was found later to be of definitely localizing value. According to Fulton, irritation of the lateral portion of the floor of the fourth ventricle can readily evoke reflex vomiting.

In some of these patients the accompanying suboccipital headaches or "pain" without further evidence of an intracranial lesion have led to multiple investigations and occasionally to extracranial procedures for the relief of pain. Such an example is the following case.

CASE 2. R. M., a woman, 36 years of age, was first seen in June 1944 because of attacks of vomiting over many years, associated with occipital headaches, and during the previous 7 months some dizzy spells if she lay on her right side. Neurologic examination showed slight ataxia in the finger to nose test and a questionable Romberg's sign. Her fundi were normal and lumbar puncture showed normal pressure. An air encephalogram showed a normal ventricular system without dilatation. She was put on a salt poor diet and ammonium chloride with some relief for a few months. She was readmitted to the hospital on November 8, 1944, with a recurrence of symptoms, but particularly "pain in the back of the head." Neurologic examination was the same as before. Because of the persistent occipital pain an occipital neurectomy was carried out on November 17, 1944. On November 24, 1944, she was still vomiting and her occipital pain was not relieved. On this date it was noted that she had a persistent, slow nystagmus to the right and left and upward, and the nasal border of the left disc was blurred. It was obvious that the suboccipital region should be explored.

Suboccipital craniotomy was performed on November 28, 1944, at which time a cyst of the left cerebellar hemisphere containing 20 to 30 cubic centimeters of yellow fluid was evacuated. A small mural nodule of solid tumor of bright red color was disclosed on the lateral surface of the cyst wall, and this nodule was completely removed by electrosurgery (Fig. 2). Unfortunately, the typical red mural nodule in this cyst was sent to the bacteriologic laboratory instead of the pathologic laboratory, and

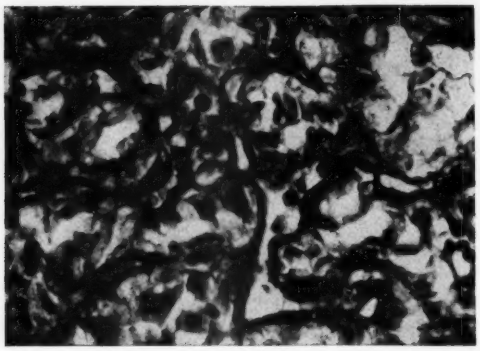


Fig. 8. High power field showing reticular fibrils outlining capillaries and swollen blood spaces. Phosphotungstic acid and hematoxylin. ×425.

was lost. The diagnosis, however, can scarcely be doubted in view of the operative findings and the gross description of the small nodule contained in the operative note as made by one of us (G. H.).

At follow-up in October 1949, five years postoperatively, the patient was in excellent health and carrying out her usual duties.

This woman presented a most difficult problem for many months. Her cerebellar signs were minimal, her optic discs were normal as were the lumbar puncture findings. Investigation was carried to the limit by an air encephalogram which disclosed a normal ventricular system. Finally, in desperation, an occipital neurectomy was carried out since no intracranial cause for her occipital pain could be demonstrated. Fortunately it was soon after this that she developed definite nystagmus and slight blurring of one optic disc. These findings led us to the correct solution of her difficulties.

Another important feature which should be emphasized in respect to the operations on these patients is the fact that even careful exploration at the time of operation may fail to disclose either a cyst or a tumor, but that after a period, with recurrence of symptoms, the cyst may be easily identified. This happened in the following case.

CASE 3. S. B., a 23 year old woman, was first admitted to the New England Deaconess Hospital on February 18, 1936, complaining of headaches, vomiting, and failing vision for 4 months. Neurologic examination showed slow nystagmus to the right and left and upward and a left abducens weakness. Her gait was unsteady and Romberg's sign was positive. Her fundi showed 6 to 7 diopters of papilledema with hemorrhages. A ventriculogram showed greatly dilated lateral and third ventricles.

A suboccipital craniotomy was carried out on February 26, 1936, following the ventriculogram. There was marked herniation of the cerebellar tonsils through the foramen magnum, and these were liberated by bony removal. The tonsils were retracted and a small rubber catheter inserted into the fourth ventricle, gently pushing it upward for a distance of 1½ inches without meeting obstruction. A needle was inserted into each cerebellar hemisphere to a distance of 5 centimeters without encountering resistance or cystic fluid. The operation was left as a cerebellar decompression.

She was completely relieved of all symptoms but was seen 1 year later because of some bulging of the right side of her suboccipital region. There were no evidences of intracranial pressure, so no operation seemed indicated.

On June 6, 1939, over 3 years since her cerebellar operation, she was readmitted because of a recurrence of headaches, double vision and spells of loss of consciousness. Examination showed a reappearance of all her cerebellar symptomatology. Reexploration of the cerebellum disclosed a greatly widened vermis within which a cyst containing 60 cubic centimeters of xanthochromic fluid was evacuated. A solid spherical nodule about 1 centimeter in diameter was completely removed from the left lateral wall of the cyst (Fig. 3).

Pathologic report indicated that the microscopic sections showed a fairly closely packed tangle of medium sized blood vessels, some of which resembled thin-walled veins and others were distinctly arteries with well developed muscular coats. Proliferation of adventitial connective tissue cells, endothelial cells and foam cells was inconspicuous, the growth representing a fairly mature development of vascular elements (Fig. 4).

After a stormy convalescence she recovered and was in excellent condition 16 months later. At follow-up 10 years after operation, a letter from the patient on November 20, 1949, stated that she was in excellent general health without disability of any kind.

Although taps had been made into both cerebellar hemispheres near the median line at the original operation no fluid had been encountered, possibly because the cyst was considerably smaller at that time. Doubtless it would have been disclosed if the vermis had been incised, but inasmuch as there was no widening of this structure at that time it was decided not to carry out this added procedure. This is obviously a matter of judgment and fortunately this patient returned for a reexploration and her lesion was removed.

Although uncommon, multiple hemangiomas or hemangiomatous cysts may occur in the same individual. There were 3 such examples in our series. In 1 instance a large cyst and solid tumor were removed from the left cerebellar hemisphere and a small surface growth from the right. In another patient, the removal of her cyst and nodule from the right lobe was followed by freedom from symptoms for 9 years at the end of which time symptoms recurred and a separate cyst and nodule were removed from the left lobe, since when she has been entirely relieved. The third patient had a cyst and nodule removed from the left cerebellar hemisphere in 1941, and a hemangioma from the thoracic spinal cord in 1948.

Air studies were deemed necessary in 17 of our 25 patients as a diagnostic measure or to confirm the clinical impression of a cerebellar tumor. In 16 instances ventriculograms were performed and in all of these there was dilatation of the lateral and third ventricles. In 3 patients the aqueduct and fourth ventricle were filled and showed displacement either laterally or anteriorly. In 1 patient an encephalogram was carried out, disclosing a normal ventricular system. In the remaining 8 cases suboccipital exploration was performed on the neurologic evidence of a cerebellar tumor.

Of interest pathologically is Case 19. The patient had had a cerebellar cyst aspirated 11 years before coming under our care. When re-explored a large cystic tumor was excised from the cerebellum. The microscopic diagnosis "cystic glioma" was returned. However, on review of the sections in preparation for this series the tumor was seen to be a typical hemangioblastoma. It is also of interest in the patient's history that a few years after her right eye had been scratched by a cat, secondary glaucoma set in and the patient became blind in that eye and "because of an angioma of the retina of her left eye, which impaired her vision, she was given radium therapy to her left eye."

Three other patients in this series had previously been operated on at other hospitals. One of these was Case 5 in which the patient had been operated on by Dr. Cushing twice and at autopsy was found to have angiomatosis of the cervical cord and medulla. He died 3 days after his third operation of medullary edema.

In Case 21 the patient had had a "simple cyst of the cerebellum" aspirated 4 years before coming to this clinic with recurrence of symptoms. At reoperation a cystic hemangioblastoma was completely excised and the patient has remained well during a period of 3 years.

In Case 23 the patient was thought to have had a fairly complete excision of one of these tumors at another hospital 7 years before being seen by us. His recurrent growth was once more apparently completely excised but since it had recurred, and remembering Case 5, he was given radiotherapy postoperatively.[1] It was felt that any possible remaining tumor was intimately attached to vital medullary centers. The patient has remained fairly well for 2 years.

### GROSS PATHOLOGIC FEATURES

In most instances the cyst occupied one or the other of the cerebellar hemispheres, although those which were situated toward the medial portion of one lobe might extend somewhat across to the other side. There were only 3 cases in which the lesion apparently arose from the vermis and, therefore, was almost entirely median. The cysts varied considerably in size. In some patients they contained as much as 30 to 60 cubic centimeters of fluid while in others, particularly those in whom a large tumor nodule was present, the cystic portion of the lesion was relatively small with only 4 or 5 cubic centimeters of fluid.

In a few patients the cysts were seen on the surface of the hemisphere but usually only widened and yellowed foliae together with dilated and tortuous surface vessels, and deeper herniation of the tonsil on the side in which the lesion was located betrayed its presence.

[1]The patient in Case 23 was the only one of this series to receive radiation therapy. It has been the policy at this clinic to give no radiotherapy to those patients whose tumors have been thought to have been completely extirpated. This course seems to have been justified inasmuch as there has been no instance of recurrence of a growth in which removal was apparently complete.

The tumor nodules, which were found in different parts of the cyst walls, and which ranged in size from a "pinhead" to that of a "small plum," were all studied microscopically except 1 pinhead-sized tumor which was inadvertently aspirated by the "sucker," and 1 characteristic bright red nodule which was lost in the laboratory. As a rule these nodules were bright red in color with a smooth glistening surface. Some of them had a deeper red color, and large venous trunks coursed over the surface of the larger growths.

### MICROSCOPIC APPEARANCE

Histologically the tumors showed many or all of the characteristics of hemangioblastomas as described by Cushing and Bailey. Typically, the parenchyma was composed of blood vessels, often capillary, separated by cords of swollen endothelial or pseudoxanthomatous cells. These intercapillary endothelial cells contained an abundant cytoplasm, many showing the vacuolated appearance which Lindau compared with the cells of xanthomas. The nuclei of these cells were palely vesicular and contained a darkly staining nucleolus. Mitotic figures, as a rule, were infrequent (Figs. 5 and 6). There was often a connective tissue reticulum as a background matrix which was demonstrated by the phosphotungstic acid and hematoxylin stain, and this stain likewise showed the reticular fibrils outlining the capillaries and the swollen blood spaces (Figs. 7 and 8).

### END RESULTS

Of the 25 patients 22 were living from 1 to 15 years after operation when last heard from. There were 2 postoperative deaths; in Case 5 the patient died after his third operation for a recurrent tumor, and in Case 6 death 14 days postoperatively was due to medullary edema and meningitis. The third death occurred in Case 3 in which the patient succumbed 1 year after the incomplete removal of her midline tumor which was attached to the floor of the fourth ventricle. This is a case mortality of 12 per cent but an operative mortality rate of only 8 per cent.

Of the 22 living patients 17 may be regarded as entirely well as they are carrying out their usual occupations with no complaints. They have no subjective or objective difficulties referable to their tumors. Five patients have been improved but still show mild or moderate cerebellar signs, complain of dizziness at times, or show other mild or moderate evidences of neurologic deficit. It is of interest to note that of the 5 patients designated as improved 4 had had previous cerebellar operations. Aspiration of so-called "simple cysts" had been performed in 3 cases, and in the fourth the tumor had been incompletely excised. The fifth patient of this group (Case 8, H.K.) is the young woman who, after an interval of 9 years following the removal of a cystic hemangioblastoma from her cerebellum at this clinic, had a similar tumor excised from the opposite cerebellar hemisphere.

### SUMMARY

1. Twenty-five cases of cystic hemangioblastoma of the cerebellum are presented. Of these, 17 patients are entirely well and 5 others improved from 1 to 15 years following operation. There were 2 operative deaths and 1 patient died subsequently. There have been no operative deaths among the last 19 patients operated on since 1937.

2. The average age at onset of symptoms was 34. A familial relationship was demonstrated in 4, or 16 per cent of the cases, and the same figures obtained for the incidence of von Hippel-Lindau disease. A relationship of trauma to onset of symptoms was determined in 5 cases, or 20 per cent of the total.

3. In view of the familial character of cerebellar hemangiomatous cysts and their frequent association with angiomas of the retina, the necessity of a careful history on this score as well as an ophthalmoscopic examination with the pupils dilated is once more emphasized in respect to all patients in whom a cerebellar tumor is suspected.

4. The hemangiomatous cysts as well as the astrocytomatous cysts of the cerebellum are the most favorable of all intracranial tumors because after evacuation of the cyst and complete extirpation of the solid tumor or mural nodule the patients are almost invariably completely free of residual symptoms or troublesome sequelae.

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# AN EVALUATION OF *PHISODERM* G-11 AND A LIQUID SOAP CONTAINING G-11 WHEN USED AS THE PREOPERATIVE SCRUB

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THE synthetic diphenol G-11 (hexachlorophene) incorporated with a bland soap has been noted to produce a marked reduction of the skin bacterial flora when used for surgical scrubbing (1, 2, 3, 4, 5, 6). This reduction was found to be significantly greater than could be accomplished with soap which did not contain the antiseptic.

Following the results of laboratory investigations, some of the observers have recommended the use of G-11 soap or detergent for the preoperative scrub to replace the conventional soap scrub and germicide rinse.

The purpose of the studies reported here was to determine bacteriologically the relative effectiveness of a bland cake soap, a liquid soap containing G-11, and a G-11 detergent when used under actual conditions existing in the operating rooms. The products employed were a bland cake soap, a liquid soap containing 2 per cent G-11 (anhydrous soap basis), and *p*HISODERM G-11. The liquid soap after dilution with water contained 0.24 per cent G-11[1]. *p*HISODERM G-11 is a water miscible emulsion containing entsufon, lanolin cholesterols, petrolatum, and 3 per cent hexachlorophene.

The materials used for the hand dips were 70 per cent (by weight) ethyl alcohol and 1:1,000 aqueous zephiran.

The subjects who participated were all members of the surgical staff of the Hospital of the University of Pennsylvania and had used a conventional soap scrub at least every other day for some surgical procedure. Prior to these studies, no G-11 soap had been used by any of the subjects for at least 5 days before any experimental observations were made. A total of 40 individuals participated in the entire series, some of these subjects scrubbing for each experiment. This constituted a total of 125 scrubs.

A modification of the Price technique was adopted after a trial series of conventional soap scrubs was carried out in the laboratory. Following analysis of the results of this preliminary series the method adopted appeared to be satisfactory for the evaluation of the G-11 compounds.

## METHOD AND MATERIALS

Specimens for bacterial cultures were obtained from separate 1 minute scrubbings performed by each subject. These 1 minute scrubbings were carried out immediately preceding and either following the preoperative scrub or following operation.

The following procedure for the 1 minute scrub was employed. Each subject using a nylon bristle brush and bar of neutral soap scrubbed both hands and forearms to the level of the elbows in a basin containing 500 cubic centimeters of distilled water for a period of 1 minute. At the end of this time the hands and forearms were rinsed with an additional 500 cubic centimeters of distilled water. The brushes, basins, and water had been sterilized previously in an autoclave under 15 pounds pressure for 30 minutes.

Immediately following each 1 minute scrubbing, 0.5 cubic centimeter specimens of the wash water were transferred by sterile pipettes to sterile Petri dishes. All cultures were prepared in triplicate. Twenty-five cubic centimeters of meat infusion agar containing 2 per cent plasma were added to each dish and the dishes agitated to provide thorough mixing of

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[1]The final concentration of G-11 after dilution of the commercial product as recommended by the manufacturer for use with a 10 minute wash without use of brushes.

the agar with the wash water specimens. At the end of 48 hours incubation at 37 degrees C. the colonies were counted with the aid of a Quebec counter. The volume of water in each basin was measured in a graduated cylinder and the number of colonies in each 1,000 cubic centimeters of wash water then calculated.

### PROCEDURE FOLLOWED FOR THE PREOPERATIVE SCRUBBING

Figure 1 shows a schematic representation of the experimental scrubbing techniques, the use of hand dips and the time of collecting the specimens for the bacteriological study.

In the preliminary soap scrub series carried out in our laboratories 16 subjects participated. Cultures were taken immediately before and after scrubbing. All of the other experiments were conducted in the operating rooms. Twenty-nine surgeons and members of the resident staff participated in the bland soap scrub series conducted in the operating rooms.

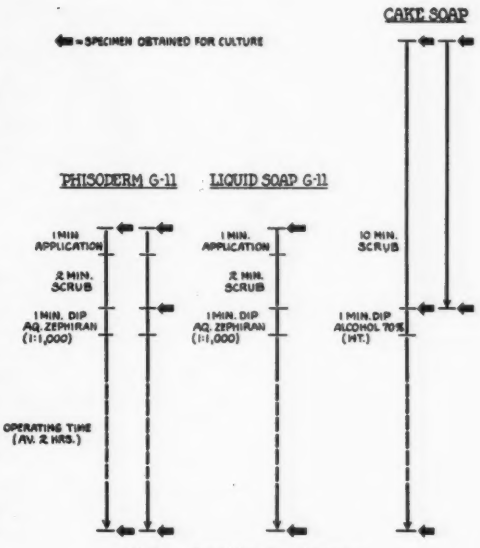


Fig. 1. Scrubbing techniques.

The same scrubbing technique was employed by both groups of subjects. Each subject scrubbed with a previously sterilized nylon bristle brush and a bar of neutral soap for a period of 10 minutes. During the scrubbing period the hands and forearms were rinsed frequently with running tap water. At the end of the 10 minute period and after the postscrub cultures had been obtained the second group of subjects immersed both forearms to the level of the elbows in 70 per cent alcohol (by weight) for 1 minute. Following the alcohol rinse these subjects were gowned and gloved, and proceeded to operate for an average of 2 hours.

When either *p*Hisoderm G-11 or G-11 liquid soap was used the subjects spread 2 cubic centimeters of either agent over both hands and forearms so as to coat the skin with a film of the G-11 agent. The agent was left in contact with the skin for 1 minute while the subjects using an orange wood stick, cleaned under the finger nails. The hands and forearms were rinsed under tap water and 2 cubic centimeters of the same G-11 product was reapplied. The subjects then scrubbed the hands and forearms for 2 minutes using a previously sterilized nylon bristle brush. At the end of 2 minutes the hands and forearms were rinsed thoroughly under running tap water and immersed to the level of the elbows in 1:1,000 aqueous solution of zephiran for 1 minute.

As the antiseptic G-11 is soluble in alcohol an aqueous solution of zephiran was substituted for the alcohol hand dip in order to permit the G-11 to remain on the hands and forearms during the time of operation.

Forty-two subjects participated in the *p*Hisoderm G-11 series and 18 subjects in the liquid soap G-11 series. In order to prevent the removal of the G-11 from the hands and forearms of the subjects following the use of either G-11 agent the postscrub cultures were taken on only 19 of the subjects using *p*Hisoderm G-11 and on none of the subjects using liquid soap G-11.

In the final series of experiments, a total of 20 individuals used the *p*Hisoderm G-11 and zephiran hand dip intermittently over a period of 1 week. These materials were used at least once a day and at least every other day for a period of 1 week.

### RESULTS

The average initial or prescrub bacteria counts are reported as representing 100 per

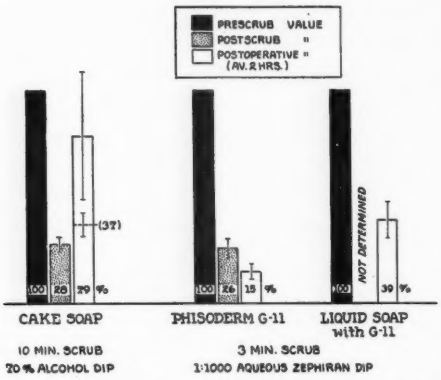


Fig. 2. Comparison of postoperative with prescrub bacteria counts after the use of *p*Hisoderm G-11 and aqueous zephiran for 1 week.

cent. The average postscrub and postoperative bacteria counts are reported as percentages of the prescrub bacteria counts. In the group of observations with the use of *p*Hisoderm G-11 and aqueous zephiran for 1 week the bacteria count after operation was compared to the prescrub bacteria count before the initial use of these agents.

The results of all the experiments are tabulated in Table I and are shown in graph form in Figures 2 and 3.

TABLE I

| Scrubbing method and agents used | Time, minutes | No. of subjects | Postscrub count* per cent | Postoperative scrub count* per cent |
|---|---|---|---|---|
| In laboratory Soap scrub | 10 | 16 | 32 | — |
| In operating room Soap scrub | 10 | 29 | 28 | 79 (37) |
| Alcohol dip | 1 | | | |
| *p*Hisoderm G-11 | 3 | 19 | 26 | 15 |
| Zephiran dip | 1 | | | |
| *p*Hisoderm G-11 | 3 | 23 | No specimen obtained | 16 |
| Zephiran dip | 1 | | | |
| Liquid soap G-11 | 3 | 18 | No specimen obtained | 39 |
| Zephiran dip | 1 | | | |
| *p*Hisoderm G-11 | 3 | 20 | No specimen obtained | 2.4 |
| Zephiran dip after 1 wk. use | 1 | | | |

*Expressed as percentage of prescrub count

TABLE II.—AVERAGE PRESCRUB COUNTS (COLONIES/C.C.) AFTER CONTINUOUS USE OF THE SCRUBBING AGENT

| | |
|---|---|
| Bland cake soap, 70% alcohol dip | 4,400 |
| *p*Hisoderm G-11, aqueous zephiran dip, 1:1,000 solution | 1,500 |

Immediately after the 10 minute scrub with bland cake soap, the bacteria count of the laboratory series was 32 per cent and of the operating room series was 28 per cent. Immediately after the 3 minute scrub with *p*Hisoderm G-11 the bacteria count was 26 per cent. No determinations were made immediately after scrubbing with liquid soap containing G-11.

Following an average operating time of 2 hours, the bacteria counts were as follows: bland cake soap and alcohol hand dip, 79 per cent; liquid soap containing G-11 and zephiran hand dip, 39 per cent; and *p*Hisoderm G-11 and zephiran hand dip 15 per cent when the intervening postscrub culture had been taken, and 16 per cent when no postscrub culture had been taken.

Following the intermittent use of *p*Hisoderm G-11 and zephiran hand dip over a period of 1 week the average bacteria count was 2.4 per cent of the original prescrub bacteria count before the initial use of these agents.

After the continued use of *p*Hisoderm G-11 and zephiran hand dip, as shown in Table II, an average of only 34 per cent as many bacteria was present in the prescrub cultures in comparison to the initial prescrub cultures taken prior to the neutral soap scrub series.

## INHIBITORS

Seastone demonstrated that colony counts were reduced greatly when G-11 in very low concentration was present in the wash water. This bacteriostatic activity could be neutralized by the addition of 1 per cent sterilized sheep serum to the agar culture media.

We were able to demonstrate this antibacterial activity by adding known amounts of *p*Hisoderm G-11 to the wash waters following the 1 minute neutral soap scrub described previously. The 1 minute scrubbings were performed by 3 individuals who had no previous contact with *p*Hisoderm or G-11. Fol-

TABLE III

| Concentration of *p*hisoderm G-11 in wash water | Per cent of colonies present in relation to control |
|---|---|
| 1:10,000 | 61 |
| 1: 2,000 | 21 |
| 1: 1,000 | 0 |

lowing the removal of triplicate specimens for culture, measured amounts of *p*Hisoderm G-11 were added to the basins to produce concentrations of 1:10,000, 1:2,000 and 1:1,000 of *p*Hisoderm G-11 respectively in each basin. Triplicate specimens of the wash waters were taken after the addition of the *p*Hisoderm G-11.

The results given in Table III show that bacterial growth was inhibited completely by a concentration of 1:1,000 of *p*Hisoderm G-11 in the wash water.

To find a satisfactory neutralizing agent which would depress the antibacterial activity of G-11 we repeated the above experiment after adding known amounts of either human plasma or human serum to the meat infusion agar. As shown in Table IV, both 2 per cent human serum agar and 2 per cent human plasma agar completely inhibited the antibacterial effect of the *p*Hisoderm G-11, even in a concentration of 1:1,000. Since human plasma was readily available through the hospital blood bank, human plasma was used in these experiments.

## DISCUSSION

Two of the individuals who used the bland cake soap had postoperative bacteria counts as high or higher than their respective prescrub bacteria counts. No errors of technique, such as tearing of the gloves during operation,

TABLE IV

| Concentration of *p*hisoderm G-11 in wash water | Per cent of colonies present in relation to control after addition of inhibitor to agar | | | |
|---|---|---|---|---|
| | 1 per cent | | 2 per cent | |
| | Plasma | Serum | Plasma | Serum |
| 1:10,000 | 98 | 101 | 101 | 102 |
| 1: 2,000 | 92 | 97 | 104 | 98 |
| 1: 1,000 | 86 | 84 | 101 | 104 |

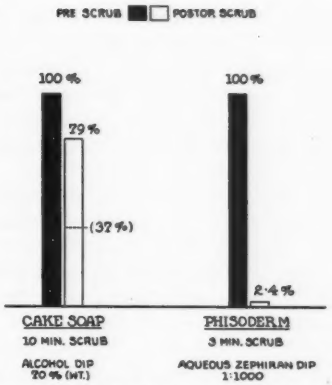


Fig. 3. Relative effectiveness after continued use.

were noted to explain these unusually high postoperative bacteria counts. If the data of these 2 individuals were eliminated from this group of observations the postoperative value of the bland cake soap would be 37 per cent instead of 79 per cent. The statistical significance of all of the values obtained have been computed and are shown graphically in Figure 2. Elimination of the 2 previously mentioned bacteria counts from their respective group would change the results as reported here only in that the average postoperative bacteria counts following the use of cake soap for 10 minutes and liquid soap with G-11 for 3 minutes would not be significantly different.

The concentrations of the G-11 products tested were those recommended by the manufacturers of these products. The 3 minute scrubbing technique used in these experiments is the technique recommended by the manufacturer for use with *p*Hisoderm G-11.

## SUMMARY

1. The relative effectiveness of bland cake soap, liquid soap with G-11, and *p*Hisoderm G-11 in degerming the skin of the hands and forearms preoperatively has been determined.

2. A single 3 minute scrubbing with liquid soap G-11 produced at least as great a degerming effect as a 10 minute scrub with a bland cake soap when comparing the bacterial counts at the end of 2 hours of operating.

3. A single 3 minute scrub with *p*Hisoderm G-11 produced an immediate postscrub

degermation equivalent to a 10 minute scrub with a bland cake soap.

4. The number of bacterial organisms which could be removed from the skin increased significantly during operation when a bland cake soap scrub and an alcohol hand dip were used preoperatively.

5. The number of viable bacteria which could be removed from the skin of the hands and arms when a *p*Hisoderm G-11 scrub and an aqueous zephiran hand dip were used preoperatively decreased significantly during an average operating time of 2 hours.

6. After the continued use of bland cake soap and 70 per cent (by weight) ethyl alcohol hand dip, 79 per cent as many bacteria could be removed from the skin after operation as compared to the number of bacteria which could be removed before the experimental scrub.

7. The intermittent use of *p*Hisoderm G-11 and an aqueous zephiran hand dip during a period of 1 week produced a marked reduction in the number of removable bacteria of the skin of the hands and arms. Following their use for 1 week and immediately after an operation, only 2.4 per cent as many bacteria could be removed from the skin as could be removed before operation and before the use of these agents.

8. A highly significant reduction of the permanent bacterial flora could be maintained when scrubbing only every other day with *p*Hisoderm G-11.

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# NONPENETRATING ABDOMINAL INJURY

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NONPENETRATING abdominal injuries are noted for their defiance of accurate evaluation and for the diagnostic acumen that is necessary to reduce their mortality. The reluctance for resolute action that attends these wounds is seldom a factor in penetrating wounds, and consequently pitfalls in the management of closed injuries are more numerous. Hicken and Carlquist attribute the mortality of nonpenetrating abdominal wounds to the surgeon's diagnostic ineptitude and not to his inability to effect a surgical correction. Mortality rates for nonpenetrating abdominal injuries are therefore directly dependent upon advice for or against operative intervention.

An analysis of 65 cases of nonpenetrating abdominal injury in patients admitted to The University of Oklahoma Hospitals during the past 25 years discloses a mortality rate of 24.6 per cent and the general premises that may facilitate a more effective management of these cases.

## ETIOLOGICAL FACTORS

The validity of certain accepted concepts of abdominal trauma may be challenged. The incidence of nonpenetrating injury is more common than previously supposed. They comprise about 47 per cent of the cases of abdominal injury admitted to The University Hospitals. Automobile accidents undoubtedly account for a large number of nonpenetrating injuries, but in our series only 27.7 per cent of the patients were wounded in this manner. That internal injuries are frequently multiple or associated with traumatic lesions elsewhere may also be questioned. In our series, only 20 per cent of the cases were so complicated.

The transmission of force within the abdominal cavity is still obscure. A single unexpected blow appears to be the more injurious. It seems, however, that once the force is dissipated against the spinal column or in rupturing or tearing a single organ, no further damage is caused. It has been suggested that the application of a narrow force affects hollow viscera and that a wide force is more likely to damage solid organs. Griswold states that a nonpenetrating force has a predilection for solid organs or hollow viscera close to their points of fixation. In most instances, injury to abdominal organs is caused by a blow that forces the viscus against the spinal column and the adjacent thick musculature (Figs. 1 and 2). Consequently, the pancreas and retroperitoneal portions of duodenum are the most vulnerably situated organs.

## RESUSCITATION

Hemorrhage and shock are immediate threats to life. Internal bleeding is difficult to estimate by external evidence, and frequent hematocrit determinations and erythrocyte counts may be necessary to detect active bleeding. Di Lorenzo and co-workers found intraperitoneal blood in 65 per cent of their cases of nonpenetrating abdominal injury. The increased susceptibility to shock of a person with a low hemoglobin demands frequent and accurate estimates of blood loss. With adequate hydration, hematocrit readings appear to be the most reliable tests of the status of the circulating blood.

Profound shock indicates a disordered autonomic nervous system and a depressed circulation. It requires prompt restabilization before operation can be considered. Most shock is the result of blood loss, and the immediate and continued replacement of blood is paramount. Morphine for pain, and warmth to supplement the circulation are valuable agents. Oxygen is indicated if pallor, cyanosis, or other evidence of hypoxemia is present. Dixon and associates describe three responses to shock treatment that determine the optimum time for exploratory laparotomy. First, those patients who respond well and remain stabilized are suitable candidates, if the indi-

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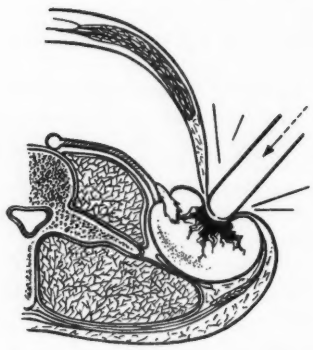

Fig. 1. Compression of kidney against spine and adjacent musculature by an external force.

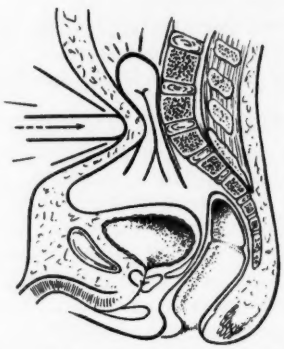

Fig. 2. Compression of bowel against sacral promontory by an external force.

cations persist. Second, those patients responding well for a short period only demand immediate operation to control bleeding. Progressive hemorrhage must be mechanically controlled. Third, those patients who do not respond to adequate shock therapy are usually hopeless and operation may serve only to hasten their demise.

## DIAGNOSIS

Diagnosis is the chief problem. Bailey asserts that the operability of an intra-abdominal injury is usually predicated upon the surgeon's ability to gauge the physical status of the patient, and to determine whether the dominating symptoms are due to shock, hemorrhage, or peritonitis. The detection and appraisal of concealed sites of damage are only properly accomplished by immediate attention and continued observation.

The clinical manifestations of intra-abdominal injury appear slowly and may be obscured by excitement, prostration, and shock. Morphine may mask the symptoms, and injuries elsewhere may divert the surgeon's attention. For several hours after the perforation of a viscus there may be a complete absence of suspicious evidence. In order to detect a hazardous injury to any viscus, frequent observations of the physical signs must be made.

Localizing signs are often overshadowed by voluntary muscle spasm, tenderness, and spasticity from contusion of the abdominal wall and reflex spasticity from fractured ribs or spine. Ileus occurs frequently with abdominal contusion. It has occurred in 57 per cent of our cases without serious intra-abdominal injury. Storck states that the type and direction of blunt force often suggest the probable location of visceral lesions. The site of trauma and the point of maximum tenderness are valuable clues. Spreading tenderness and muscle rigidity are strong indications for surgical intervention.

Certain diagnostic procedures are mandatory in every case of suspected intra-abdominal injury. A complete blood count, hematocrit, and urinalysis for evidence of gross or microscopic bleeding are necessary. A suppression of urine may cause considerable delay in the appearance of hematuria. An upright x-ray film of the abdomen is required to detect the presence of free air. A negative reading does not preclude injury to hollow viscera and whenever there is reasonable doubt, an exploratory procedure should be done. When urinary bladder injury is suspected, installations of sodium iodide solution should be followed by roentgenograms. Evidence of internal bleeding may be found on the rectal glove or by examination of vomitus. Glenn and associates state that if there is retroperitoneal hemorrhage, the extravasation around the sympathetic ganglia may produce a bluish discoloration of the lower extremities and a semierection of the penis.

Infection may follow the initial insult. This is particularly true if rupture of a hollow

organ has occurred, and studies should be undertaken to anticipate suppuration. Leucocytosis will appear with active or quiescent hemorrhage. A fever, however, marks the establishment of an infectious process.

### OPERATION

"Peritonism" or "traumatic peritonitis" is described by many authors. The syndrome is produced by blunt shock to the celiac plexus or by injuries to the back and thorax. It simulates the clinical picture of severe visceral damage and internal hemorrhage. Under primary shock treatment, the symptoms disappear and the shock picture vanishes and no indication for operation remains. Hinton says that about 70 per cent of all abdominal contusions are of this character and that exploration is needless. In our series, 14 cases of traumatic peritonitis were recorded. They comprised 22.9 per cent of the cases of nonpenetrating injury. Three of these patients were operated upon. Despite this, it is sometimes wiser to risk an unnecessary operation while the patient's condition is good than to delay surgery in the face of progressive hemorrhage or intestinal perforation. Laparotomy is usually indicated in the following circumstances: (1) definite evidence of a ruptured hollow viscus, (2) kidney damage with excessive hemorrhage, (3) increasing abdominal pain and rigidity, (4) ruptured urinary bladder, (5) probable internal injury with evidence of active bleeding. Table I reveals a remarkably low incidence of mortality following operation and a high number of deaths associated with conservatism.

### RUPTURED KIDNEY

Despite the protective proximity of thick musculature and rigid bony structures, the genitourinary organs appear to be the most vulnerable to blunt force that does not penetrate the abdominal cavity. In our series, injury to a genitourinary organ constituted 36.9 per cent of the cases.

The diagnosis of contusion or rupture of the kidney was made in 15 cases. Associated rib fracture was present in 4 cases. Hematuria, pain in the flank, and unilateral muscle rigidity are the usual diagnostic criteria. The progressiveness of hemorrhage that escapes into the kidney pelvis or ureter may be estimated by comparing successive examples of urine. An isolated episode of hematuria 3 to 5 days following the injury may mean that a clot in the kidney pelvis has been dislodged. Continued passage of lightly stained urine may be due to the washing of clots in the urinary bladder. Within the first 24 hours, no reliance can be placed on excretory urograms to estimate the severity of kidney damage. After that time, the untraumatized portion of the kidney will secrete dye. If the kidney fails to secrete any of the contrast media there is strong evidence of severe damage. If a concentration of dye is seen outside the pelvis or in the ureteral areas, there is a presumptive evidence of extravasation.

TABLE I.—NONPENETRATING ABDOMINAL INJURIES

| Site of injury | No. of cases | No. operated upon | No. of postoperative deaths | Total No. deaths |
|---|---|---|---|---|
| Kidney | 15 | 3 | 0 | 0 |
| Abdominal parietes | 14 | 3 | 0 | 0 |
| Urinary bladder | 9 | 6 | 0 | 3 |
| Liver | 9 | 2 | 0 | 4 |
| Intestine | 7 | 3 | 0 | 4 |
| Spleen | 6 | 2 | 0 | 1 |
| Unknown | 3 | 0 | 0 | 2 |
| Pancreas | 1 | 1 | 1 | 1 |
| Liver and right renal artery | 1 | 0 | 0 | 1 |
| Totals | 65 | 20 | 1 | 16 |

The majority of kidney injuries require no intervention. In only 3 of the 15 cases mentioned was surgical intervention necessary. The innocuous nature of most kidney injuries is demonstrated by the fact that in the 15 cases presented, there were no deaths.

### RUPTURED URINARY BLADDER

The full urinary bladder is frequently injured. It is the second most frequently injured organ in this series. The bladder may be punctured by bony fragments from a fractured pelvis. Four of the 9 cases reported were associated with a fractured pelvis. An intraperitoneal or extraperitoneal tear may result. Suprapubic pain, hematuria, low abdominal

TABLE II.—MORTALITY RATES

| Site of injury | No. of cases | Mortality rate per cent |
|---|---|---|
| Liver and rt. renal artery | 1 | 100.0 |
| Pancreas | 1 | 100.0 |
| Unknown | 3 | 66.6 |
| Intestine | 7 | 57.1 |
| Liver | 9 | 44.4 |
| Urinary bladder | 9 | 33.3 |
| Spleen | 6 | 16.6 |
| Kidney | 15 | 00.0 |
| Abdominal parietes | 14 | 00.0 |
| Totals | 65 | 24.6 |

rigidity are prominent findings. A cystogram after the introduction of 5 per cent sodium iodide solution establishes the diagnosis. Surgical repair is the only treatment. The 3 deaths from ruptured urinary bladder reported in this series were in patients who were not operated upon.

### RUPTURED SPLEEN

If the primary hemorrhage is not fatal in injuries of the spleen, the bleeding may cease temporarily. However, continued oozing within the splenic tissue may force the extravasation of considerable amounts of blood into the peritoneal cavity within a few hours. Delayed hemorrhage is a dangerous possibility, and the secondary shock may be postponed for as long as 24 hours. A nonshifting dullness in the left flank and pain in the left shoulder region suggest the diagnosis. Clinical signs and repeated hematocrit readings will disclose progressive hemorrhage. The treatment for continued bleeding is splenectomy. In our series of 9 cases, 2 patients were operated upon and both recovered. One of the patients treated conservatively died.

### RUPTURED LIVER

Hemorrhage is the chief danger. When the tear is sufficiently deep into the liver tissue that major bile and venous tributaries are severed, the escaping bile retards clotting and encourages infection. Laceration on the convex surface in a sagittal plane is probably the most frequent traumatic lesion. Frequently these patients exhibit a slight jaundice. Dullness in the right flank is an almost constant feature. Tenderness and muscle rigidity in the right upper abdomen are important signs. At operation, the bleeding may be controlled by packing the defect with oxycel or gelfoam and suturing it into position. The omentum may also be utilized. Di Lorenzo places the mortality at 25 per cent. In our series of 9 cases, the mortality rate was 44.4 per cent. An exploratory operation was performed in only 2 patients in this group and both patients recovered. In the cases treated conservatively, the mortality rate was 57.1 per cent.

### INTESTINAL INJURY

In a review of the literature, Poer found 1,476 cases in which perforation of the intestinal canal was caused by injury which failed to penetrate the abdominal wall. The operative mortality in these cases was 60 per cent. Under the most favorable circumstances, the mortality rate is 35 per cent. Shapiro states that 58 per cent of traumatic perforations occur in the first 3 feet of jejunum or the last 3 feet of ileum where bowel loops may be compressed against the vertebral column. Ficarra's contention that hematemesis is a prominent occurrence with perforation of bowel near the ligament of Treitz is based on the appearance of blood in the vomitus of 5 out of 7 patients. The lesion is frequently a combination of frank perforation of the intestine and hemorrhage from the corresponding mesentery. By close observation of the patient and the response to shock therapy traumatic peritonitis may be differentiated from visceral injury.

In our series, there were 7 cases of intestinal perforation from nonpenetrating trauma. The mortality rate in this group was 57.1 per cent. Only the patients operated upon (3) survived. Aird and Bruce report the traumatic rupture of intestines situated in inguinal hernias. One of our cases was of this nature.

### MORTALITY

The causes of mortality are shock, hemorrhage, and infection. Mulholland, in a survey of all abdominal traumas, ascribes 43 per cent to infection, 43 per cent to shock, and 14 per cent to hemorrhage. Comparisons of death

rates from open and closed abdominal wounds are not significant. Mortality rates for penetrating injuries vary from 17 per cent to 42 per cent. In our series, the mortality rate for nonpenetrating injuries was 24.6 per cent.

The mortality associated with the various sites of injury inflicted by nonpenetrating trauma differs. Injury to structures adjoining the celiac plexus seems to carry the highest mortality. In our series, the mortality at various sites is recorded in Table II. The comparison of mortality rates for conservative treatment and operation reveals a striking difference. With operative treatment, the mortality rate was 5.0 per cent; with conservative management, the mortality rate was 33.3 per cent.

## SUMMARY

Sixty-five cases of nonpenetrating abdominal injury are presented. The detection and interpretation of localizing signs are discussed, and frequent observations of the patient, particularly the response to shock therapy, are advocated.

Because of the close relationship of shock and hemorrhage, early and adequate replacement of whole blood is necessary. The decision for exploration is dependent upon the clinical findings. A slow response to shock therapy and evidence of progressive hemorrhage or visceral perforation are indications for operation. The poor results from conservative treatment are shown in Table I.

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## POSTTRAUMATIC EPILEPSY

THAT epilepsy may follow an injury to the head has been recognized for centuries. During man's entrance into this world, the physical stresses of the parturient canal and cerebral anoxia threaten the integrity of his brain. Cerebral injury during birth is thus a frequent occurrence and predisposes to a focal epilepsy. Whether it may be responsible for the so called idiopathic or genuine epilepsy has not yet been determined. Closed head injuries in later life are followed by convulsive states in about 3 per cent of cases; in open wounds, if the dura mater is penetrated, the incidence of epilepsy may be as high as 36 per cent. Convulsions are somewhat more likely to occur if the injury is in the vicinity of the central sulcus than if it is polar. Infection of a compound wound of the head seems also to increase the likelihood of seizures.

A decrease in the incidence of posttraumatic epilepsy should come from prophylactic measures to minimize birth injuries, to eliminate asphyxia of the newborn and to prevent infection of compound wounds of the skull by early and thorough débridement and the use of antibiotic and chemotherapeutic agents. Perhaps the early repair of traumatic cranial defects by cranioplasty may prevent the convulsive diathesis.

If epilepsy develops, the odds are better than even that the attacks may be eliminated by anticonvulsant therapy. The drugs now available (phenobarbital, dilantin, bromides, mesantoin, tridione, paradione, mebaral and phenurone) constitute an imposing list and allow a choice of several drugs for each variety of convulsive attack. To be effective in most cases, these drugs must be given in doses which approach the limits of toxicity. Unfortunately, some of the drugs, particularly the newer ones, have undesirable side effects, so that their administration requires careful medical supervision. Every posttraumatic epileptic is entitled to a thorough trial of medical management before surgical intervention is contemplated.

In the past fifty years many different types of surgical procedures have been attempted for the relief of epilepsy. Some have been based upon sound physiological principles, others upon fallacious reasoning. Owing to the capriciousness of the disease and tendency for periods of freedom from attacks to follow almost any change in habit, each procedure initially has been propounded enthusiastically and then allowed to fall silently into discard if time demonstrated the futility of the measure. Our present surgical treatment of posttraumatic epilepsy has been developed largely by Victor Horsley, Otfrid Foerster, and Wilder Penfield.

At first posttraumatic epilepsy was considered due to something intrinsic within the cortical scar and surgeons excised the cicatrix with varying results. As experience in electrical stimulation of the exposed lesion accumulated, it became evident that the scar was inert and the epileptogenic focus was a zone of pathological cortex adjacent to the gross lesion. The accurate localization of this epileptogenic focus is a prerequisite to operation.

The history of the injury may give a clue to the site of origin of the seizures, by indicating the location of the wound. But, if the beginning of the attack does not correlate with the apparent injury, *contrecoup* effects must be considered or the posttraumatic origin of the epilepsy questioned. Relatives and patients, to avoid the stigmas commonly attributed to idiopathic epilepsy, are given to exaggerate head injuries which they hope may be considered related etiologically to the convulsions. Although focal epilepsy usually results from cerebral trauma, at least 25 per cent of patients suffering from posttraumatic epilepsy due to wounds of World War II had no warning of their attack and no apparent focal signs. But the clinical description of the attack in most cases will allow the physician to deduce the site of origin from knowledge of cortical physiology. If the description is vague or the witnesses unreliable, it may be well to evoke a seizure by the slow intravenous injection of metrazol. By observing the induced convulsion which is identical to the spontaneous seizure, the physician can study the development of the attack.

By electroencephalography the location of the epileptogenic zone may be determined. In the vicinity of damaged cerebral tissue, the brain waves are slower than normal, and if convulsive activity is present, often accompanied by spikes. If such discharges are not present in the routine record, they may be induced by one of the activating techniques such as hyperventilation, metrazol or photic driving. In contrast to such focal activity in posttraumatic epilepsy, the electroencephalograms of patients with idiopathic epilepsy are generally disorganized or slow. By this dysrhythmia the genuine epilepsies—unsuitable candidates for our present surgical procedures —are differentiated from the symptomatic epilepsies. At times ancillary procedures such as pneumoencephalography or angiography are valuable aids in confirming the presence of a cerebral scar.

Having determined the location of the epileptogenic focus a suitably placed craniotomy may be made under local anesthesia. The co-operation of an awake patient is essential to the effective exploration of the cortex, for often the aura of the attack is a subjective phenomenon.

The epileptogenic focus, situated adjacent to the cerebral scar consists of pathologically altered cortex, the prime characteristic of which is hyperirritability. Since irritability is a functional rather than an anatomical attribute of a neurone, it is not surprising that the epileptogenic focus has no gross anatomical characteristic which distinguishes it from the remainder of the cerebral cortex adjoining the lesion. To make the differentiation, it becomes necessary to explore the cerebral cortex with an electrical current while recording directly by means of electrodes placed upon the cortex of the conscious patient. If the central area is exposed, a general orientation is first obtained by locating the motor cortex. The margins of the cerebral scar are then studied.

An epileptogenic focus can be determined by localized spontaneous spiking, induction of the patient's aura by electrical stimulation, production of a long lasting after-discharge or the initiation of focal spiking by local or sys-

temic administration of a convulsant drug. None of these phenomena alone is an absolute criterion of a focus. But if a spiking focus, adjacent to pathological cortex, is hypersensitive to chemical and electrical stimulation and gives rise to the patient's aura one may say with reasonable certainty that it is the epileptogenic focus. The localization of an epileptogenic focus is difficult and requires not only electrocorticography, but a careful integration of the clinical history of the attacks with the anatomical and physiological findings at operation. By making electrocorticographic records from the brain of the unanesthetized patient as the surgical techniques are in progress the surgeon may determine that his ablation is not producing undesirable neurological deficits and may verify the completeness of his surgical extirpation of the focus.

The type and extent of cortical resection varies greatly. Subpial resection of the epileptogenic focus may be adequate and causes the least subsequent scarring. If the scar involves a large area at the pole of the hemisphere and the focus is extensive, a partial lobectomy may be advisable. If the scar involves an entire hemisphere, as occurs in children with infantile hemiplegias, a hemispherectomy may be made. It is amazing that the removal of an atrophic scarred hemisphere in a child who has had convulsions and hemiplegia since infancy does not impair further the strength of the hemiplegic limbs and will actually improve the general mental and physical status of the child.

The results of surgical removal of epileptogenic foci in posttraumatic epilepsy, while not spectacular, are encouraging; especially when it is considered that the surgeon enters the arena only when the physician admits failure of medical management. Approximately one-fourth of the patients are freed completely of seizures, another fourth very markedly improved, one-third somewhat better, and one-sixth unchanged.

Finally it should be emphasized that the treatment of posttraumatic epilepsy requires a team: medical neurologist, who after a complete examination prescribes medicinal therapy until it proves futile; electroencephalographer, who localizes the epileptogenic focus both before and during craniotomy; surgeon, who, after careful evaluation of the clinical history, neurological findings, electroencephalographic examinations and special tests, makes a craniotomy under local anesthesia, explores the cortex with the aid of the electroencephalographer and finding the epileptogenic focus removes it; and finally the neurologist, who again prescribes anticonvulsant medication and endeavors to rehabilitate the patient. With the full co-operation of this highly specialized team the surgical therapy of posttraumatic epilepsy offers considerable promise to a group of epileptics who otherwise would be considered incurable.

A. Earl Walker.

## GASTRIC CARCINOMA

THE percentage of cures in gastric carcinoma achieved by surgical treatment—the only possible treatment today—is not more than from 5 to 7 per cent of all patients.

Since the incidence of these neoplasms in all the civilized countries of the world is so great, this problem is of extraordinary importance. In Chile our results are somewhat inferior to those reported from prominent surgical clinics in the United States (the Mayo Clinic, the Lahey Clinic, Pack, Wangensteen), probably due to the fact that our patients delay longer before consulting us than in the centers mentioned.

What are the fundamental facts which explain the poor results of surgical treatment? One must consider first, if the results are due to failure of our diagnostic procedures. In our opinion diagnostic procedures such as roentgenography, gastroscopy, cytodiagnosis in the hands of experienced workers permit one to make a correct diagnosis in 100 per cent of the cases. Nevertheless in our surgical center in Santiago de Chile where in the past 11 years (1938–1949) we have cared for 575 patients with gastric carcinoma, we could operate on only 446 of them (77.56 per cent) and perform a resection of the tumor by partial gastrectomy, total gastrectomy or gastroesophagectomy in only 252 (56.50 per cent). Twenty-three per cent of the patients operated upon reported clinical symptoms dating from 1 to 3 months previous to the operation. In 50 per cent of the patients of this group it was no longer possible to eradicate the carcinoma, 19 per cent of the patients acknowledged symptoms present for from 3 to 6 months, and in 63 per cent of these it was impossible to extirpate the growth.

These percentages speak for themselves, and we infer from them that approximately 25 per cent of gastric carcinomas develop silently, without giving noticeable signs of their presence. When evident, half of them are inoperable.

In the type of gastric carcinomas of short clinical duration one cannot derive benefit from the early diagnostic procedures mentioned—that is to say one cannot anticipate curative treatment of the carcinoma. The second group, with symptoms present for from 3 to 6 months of illness, suggest somewhat different considerations than the preceding group. Here, the patient and the doctor have had more than the necessary time to recognize the condition. It is in this group, however, that we find the lowest rate of operability, a rate similar to that in patients with symptoms present for more than 2 years. In these cases we were able to carry out a radical operation in only 37 per cent. We are certain that in this group of patients the responsibility for the bad results must be shared by the patient, who attached no importance to the prolonged symptoms of his illness, and by the doctor, who was not equipped to carry out the necessary examination for establishing an early diagnosis.

A great improvement can be attained, first, by educating the public through public assistance organizations, by teaching patients to attach more importance to their first symptoms, even though slight, and by acquainting them with the circumstances under which the illness appears. Second, by modifying the teaching concerning cancer in the medical schools and definitely putting aside the classical descriptions of the illness that usually describe only the final period when very little or nothing can be done. We must teach the public in general and medical students and physicians to suspect the condition by intelligent appraisal of the few symptoms by which the disease becomes apparent and we must teach physicians modern diagnostic procedures.

There is still something, however, which requires explanation: the poor results of surgical treatment in gastric carcinoma. Are the available surgical techniques effective, and does the surgeon always select the correct method in each particular case? We can be sure that the surgeon experienced in the treatment of gastric cancer is capable at the present time of eradicating gastric neoplasm wherever it may be found (pylorus, cardia, or entire stomach) as long as it is operable. Such radical surgery is accomplished today in specialized centers with relatively low rates of mortality and high standards of resectability. We have devoted a good deal of our surgical

activity to this field of surgery and during the last 2 years (1947–1949), have carried out 62 gastric resections of varied types. This group represented the 26 per cent of cases which were operable. The immediate postoperative mortality was 12.9 per cent (partial gastrectomies, 20 with 5 per cent mortality; total gastrectomies, 30 with 13.3 per cent mortality; gastroesophagectomies, 12 with 25 per cent mortality). Therefore we can conclude, that we have available adequate surgical procedures to attack gastric neoplasms with a fair operative risk.

In 1946 we were able to follow the results of 100 subtotal gastrectomies for gastric cancer in a group of 143 patients operated on by this method (69.93 per cent of the patients operated upon). Of 100 cases 40 showed evident signs of relapse and in *45 per cent of these the recurrence was located exclusively in the preserved gastric stump*. This was verified in all the cases by both roentgenography and gastroscopy.

We know that dissemination of gastric carcinoma takes place by three different routes: along the blood vessels, along the lymphatics toward the outer wall of the stomach (regional ganglia), and along the intramural lymphatics. The surgeon, no matter how radical his ablation may be, can do very little when hematic metastases are present. He can also do very little when the disease has extended beyond the stomach and invaded the regional lymphatic chains, or if it is already generalized at the moment of operation. He can do more in relation to the intramural invasion by attempting total gastrectomies in all those cases in which he believes that radical surgery is possible, leaving subtotal gastrectomy as the method of choice when only palliative surgery is indicated. In our operations for recurrence in the gastric stump, mentioned, we saw that recurrences took place although the line of resection was 4 centimeters or more beyond the macroscopic limits of the neoplasm.

When we say that total gastrectomy is the only radical operation for gastric cancer, especially when the neoplasm is relatively small, we do nothing but apply to the stomach the general principles of the surgery of cancer. With these principles in mind since the middle of 1946 we have widened more and more the indications for total gastrectomy. Starting from that date, that is to say during the last 3 years, of a total of 80 gastrectomies for carcinoma (gastroesophagectomies not included) the number of subtotal gastrectomies and total gastrectomies has been exactly the same, 40 of each; but the percentage of the latter has constantly increased: in 1946–1947, 26 per cent; in 1947–1948, 48.38 per cent; and in 1948–1949, 66.66 per cent. Subsequent to our study mentioned above and the attitude adopted as to radical treatment we acknowledged the work of Longmire, presented in SURGERY, GYNECOLOGY AND OBSTETRICS in January, 1947 in which he draws conclusions similar to ours.

We have already pointed out that our percentages of cure have been mediocre; actually in the period between 1938 and 1946 the rate of survival of over 1 year after subtotal gastrectomy has been 61 per cent; of over 2 years 31 per cent; of over 3 years 17 per cent; of over 5 years 11 per cent; of over 6 years 6 per cent.

We sincerely hope that with this new attitude toward the problem of radical surgery in gastric carcinoma, and especially with the help of better education of the public and better education of new medical generations there will result a definite improvement in the prognosis of this dreadful disease.

FELIX DE AMESTI.

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## PRESIDENTIAL GUNSHOT WOUNDS

### Three Case Reports

ESTHER H. VINCENT, Evanston, Illinois

CASE 1. A. L., aged 56.

Shot in the head while sitting in a box built out over the stage of Ford's Theatre, Washington, at about thirteen minutes past ten o'clock, on the night of April 14, 1865.

He was sitting in a high-backed rocking chair placed by the management in the corner of the box nearest the audience, his left side being visible to the people on the far side of the dress circle, but hidden from the others by a curtain. His left arm rested on the box railing. During the third act of the play, *Our American Cousin*, the hero was standing alone on the stage as laughter and applause greeted his parting remarks to a couple of actresses. Some disturbance in the audience caused the President to turn his head sharply downward and to the left. At this point, the popular young actor, John Wilkes Booth, entered the box and shot him with a Derringer pistol. Thus, although Booth stood at his victim's right, the bullet entered the left side of the head.

Booth dropped the pistol and drew out a knife with which he slashed the arm of Major Henry R. Rathbone, who attempted to seize him. He then leaped to the stage, catching his spur on the flag draped box and breaking his leg. Melodramatically shouting "Sic semper tyrannis," he sped on horseback through the night, only to die, presumably by his own hand, as he was about to be captured a few days later.

Meanwhile, the screaming wife of the President was holding him upright in his rocking chair, although he was apparently dead, his eyes closed, his head fallen forward. The first physician to reach the wounded man was Dr. Charles A. Leale, a twenty-three year old assistant surgeon in the United States Volunteers. He felt of the pulseless wrist, and then laid the President on the floor, while Laura Keene, star of the play, supported the drooping head. A large clot of blood on the left shoulder suggested a knife wound, but, on slitting both coat and shirt, no such injury was found. Since the thick black hair had absorbed much blood, the head wound was not easily visible, but, on finding optical evidence of brain injury, Dr. Leale searched for and found the clean-cut bullet-hole. He quickly removed the blood clot, thus easing the intracranial pressure. The unconscious body responded feebly with shallow breathing and weak pulse.

With the help of two other physicians, Taft and King, Dr. Leale then resorted to artificial respiration, rhythmically moving the arms up and down, and pressing upward on the diaphragm and under the left costal border. Finding the pulse and respiration improving, he tried forcible mouth to mouth breathing, which finally produced independent heart and lung action. A small quantity of diluted brandy was swallowed and retained. Thus death was checkmated for a time.

Since the streets of Washington were full of ruts and holes, or, at best, paved with cobblestones, transportation to the White House was not to be thought of. So the wounded President was carefully carried across the street to Petersen's boarding house. Here, the long, helpless body was laid diagonally on the too-short bed, the head being propped with pillows in such a way as to promote continuous drainage of the wound. The President was gently undressed to permit examination for possible other wounds. Hot water and blankets, and even mustard plasters were brought in order to produce warmth and to stimulate circulation in the cold extremities. The heavy breathing, indicating brain compression, was al-

From the Archibald Church Library, Northwestern University Medical School.

leviated by removal of the clots of blood which kept forming at the wound opening. Finger probing failed to find the bullet. One teaspoonful of brandy was chokingly swallowed, but another, ten minutes later, could not pass the throat. The eyes showed no reaction to light. The left upper eyelid was darkly swollen from blood diffusion, and the left pupil was contracted. The right eye was greatly dilated, later becoming discolored and protuberant.

Dr. Stone, the family physician, now took charge, along with Surgeon-General Barnes and his assistant, Dr. Crane. During the long night, other medical men wandered in and out, mingling with the stunned Cabinet members. Dr. Abbott made a detailed record of the President's pulse and respiration. About 11:30, following the double exophthalmos, there took place a fifteen or twenty minute period of twitching of the left side of the face, the mouth being drawn somewhat to the left. At one o'clock, muscle spasms developed in the forearms and chest, relieved by sudden expulsive expirations. At two o'clock Dr. Barnes began searching for the bullet. He used an ordinary silver probe, which met an obstruction about three inches deep. A long Nélaton probe was able to pass the bone plug, and to come in contact with the bullet about two inches beyond. Deeper probing revealed broken segments of the right orbital plate of the frontal bone.

About five o'clock the blood ceased to ooze from the wound, and the breathing grew loud and labored, completely stopping at intervals. At 7:21 respiration ceased forever, and a minute later came the final heart beat. Most patients with this type of injury would have died in two or three hours. This one lived for nearly nine hours.

The autopsy was held in the White House on Saturday morning, April 15, just five hours after death. Examination was limited to the head. The bullet had entered the occipital bone at the level of the transverse sinus about an inch (2.5 cm.) to the left of midline. The path led obliquely forward across the brain and came to an end in the right frontal lobe. Extensive comminuted fractures of both orbital plates occurred, but the dura mater was not touched. Reconstruction on anatomical charts shows the bullet path extending across the upper surface of the pons and through the sylvian aqueduct. The fracture of the orbital plates was most unusual and is generally attributed to *contrecoup*.

In the *London Lancet* of June 17, 1865, T. Longmore, a professor of military surgery at the Army Medical School, agreed that the fractures were caused by the brain being driven against the orbital bones by means of the bullet impetus. But W. F. Teever, F. R. C. S., surgeon at the West London Hospital, thought that such transmission of force could not have occurred, since the bullet struck the occiput with such velocity as to make a sharp, clean-cut hole, the exact size of the missile. He believed that the bullet was "spent" as it struck the right orbit and that it rebounded without injuring the dura. A spent bullet will fracture a long bone even if does not penetrate the clothing. Teever thought that the left orbital fracture was an extension of that of the right, and that a more exhaustive examination would have disclosed the communication.

The bullet was made of britannia metal, a hard alloy of tin, copper, and antimony. It was flattened, convex on both sides, and evidently had been made by hand in a Derringer pistol mold, since it had a ridged surface left by the nippers in clipping off the neck. A small piece of the bullet, evidently cut off in passing through the bone, was removed from the path about four inches from the external wound. A plug of occipital bone, driven forward by the bullet, was found in the track about three inches deep. The bullet and fragments, together with the bones of the orbital plates and the plug from the occipital bone, were given by Dr. Stone to the Secretary of State, who sealed them with his private seal. With the probe, marked by Dr. Taft and sealed in a similar manner, they may still be seen at the Lincoln Museum in Washington.

The autopsy was performed by Dr. J. J. Woodward, while Dr. Taft and the other physicians concerned looked on. Young Dr. Leale, however, had found his adventures of the night too much for him, and begged to be excused. The surgeons present reported somewhat divergently on several points, notably on the exact location of the bullet. But, considering the exhausted physical and emotional states of the sleepless men, certain inaccuracies are not at all surprising. There was some confusion over a possible gravitational shifting of the bullet from left to right. It is generally agreed now that the shattered eye-sockets were the result of sudden pressure transmitted to the bullet, breaking down the orbital plates at the points of least resistance. The low velocity of the bullet, its relatively heavy weight, and the fact that it was fired at very close range, all tended to produce a sudden impact of great force. Wounds from Derringer pistols held about two feet from the target were very rare, since such a distance would be too close for combat and too far for suicide.

In view of its central location near vital centers, it is surprising that the wound was not instantly

fatal. Many of the pathognomonic signs of severe intracranial injury were recorded by Dr. Taft. Deep coma, pulse rate of 48 beats per minute, unequal pupils finally becoming widely dilated, bilateral Jacksonian convulsions and shallow respirations becoming Cheyne-Stokes in character are mentioned. Marked exophthalmos, with extensive ecchymosis of the sclera and periorbital tissue, was associated with the fractures of the orbital plates.

With such an extensive wound across the brain, it seems doubtful if the outcome would be any different today. The necropsy report does not state the occurrence of much intraventricular hemorrhage, but mentions subdural clots. Had these clots been evacuated, it is probable that destruction of tissue in the region of the pons would still have proved fatal.

Only a miracle would have prevented death. If the President had survived, he probably would have suffered from various forms of nervous disorders. He would have been paralyzed, totally blind, and mentally incapable. Destruction of the brain tissue was so extensive that the personality may be said to have gone with the entry of the bullet into the skull. As it was, the President passed gently from unconsciousness into oblivion.

CASE 2. J. A. G., aged 50.

Shot in the abdomen at close range, while walking through the Washington station of the Baltimore and Potomac Railroad on July 2, 1881. He was en route for a trip north and a visit to his old college, Hiram, where he had both studied and taught. He was shot by Charles Guiteau, a psychoneurotic lawyer, who had been disappointed in finding a political job. Guiteau loudly declared that his was a political crime, that he was a "Stalwart" (political group of the time), and that he wanted Arthur to be chief executive of the nation.

The President was a large man, about six feet tall, with great breadth of shoulder. The bullet entered the tenth intercostal space about three inches (7.5 cm.) to the right of the midline and fractured the eleventh rib. Because of its velocity, the lead ball was then deflected down and medially across the body of the first lumbar vertebra. It passed completely through the body but missed the spinal canal. It then buried itself under the peritoneum near the spleen after grazing the edge of the splenic artery.

Few cases in medical history have brought forth so much discussion and comment. It was usual at that period to pay great attention to the location of the bullet, but, in the absence of x-rays, this was not easy. Reliance was placed on a reconstruction of the relative positions of the assassin and his target, and also on prolonged (and unhygienic) probing of the wound. In this case, the scene at the station was reconstructed, and bullets were shot into cadavers in an attempt to reproduce the wound. Inventor Alexander Graham Bell was asked to conduct electrical experiments to determine the location of the bullet, and many elaborate instruments, similar to some modern bronchoscopic forceps, were devised to reach along the tortuous path and seize the bullet for extraction. However, as is well known, the presence of a bullet in the body is entirely compatible with life. The attending physicians were plagued by letters from medical men from all over the world, and were accused of malpractice by editorial writers in medical journals.

Nevertheless, Dr. D. W. Bliss, with the assistance of Dr. Frank Hamilton and Dr. Hayes Agnew, managed to institute what was very good treatment for the time. Three operations were performed by Agnew and Hamilton, unfortunately without benefit of aseptic surgery. Consequently, about a month after the shooting, several subcutaneous abscesses appeared around the wound of entry. On two occasions the sinus tract was incised to promote better drainage. Later, severe suppurative parotitis developed, necessitating incision and drainage.

Everyone connected with the case was under great strain, not only because of unwelcome advice and irritating criticism, but because of the great heat of Washington in summer. One of the first air conditioning units in the country was installed in the White House to cool the sick room. But even with this, the temperature was too high for comfort, and after eleven weeks of heat, the President was taken to Elberon, New Jersey, a family summer resort. Official bulletins were numerous but hardly revealed from day to day whether he was incapacitated in the meaning of the Constitution or not. He never left his bed, however, and during his illness, his weight fell from 210 to 125 pounds. Following a temporary period of improvement, he grew much weaker and died on September 19, after a sudden hemorrhage from aneurysm of the splenic artery.

The only significant anatomical revelation at the autopsy was the large amount of blood in the peritoneal cavity secondary to the rupture of the splenic artery. The everted edges of the wound were united by firm adhesions to the adjacent connective tissue. It was thought by some that these adhesions formed a barrier against complete exsanguination, and that it was only when these bands could no longer hold back the escaping

clotting blood that death became inevitable. But many surgeons refused to accept this explanation, notably Dr. William A. Hammond and Dr. J. Marion Sims. In an article in the *North American Review* for December, 1881, Dr. Hammond asserted "that the rupture of the splenic artery was due either to malnutrition of the coats, the result of pyemia, or was post mortem, being caused by the injection of a solution of chloride of zinc into the vessels several hours before autopsy. If the latter was the case, the blood found in the peritonal cavity was pushed out by this fluid which, of course, filled all of the vessels, and which, it is admitted in the report of the post mortem examination, was extravasated into the abdominal cavity with the blood." Dr. Sims agreed, concluding, "Therefore, the rupture of the artery may have happened during the act of embalmment."

These conclusions were strongly challenged by Dr. William Hunt, senior surgeon at Pennsylvania Hospital, and former demonstrator in anatomy at the University of Pennsylvania. Hunt gave anatomicophysiological reasons why the Hammond-Sims conclusion was incorrect. He believed that the watery solution filled the arterial system and escaped after death in the same place where the blood had escaped before death. He thought the injection a good thing, "as it helped to prove the existence of an arterial rent or rupture before a knife was put in the body."

Cause of death was finally given as sepsis occurring along the course of the bullet wound and rupture of an aneurysm of the splenic artery, which developed at the site where the bullet grazed the vessel.

Treatment was good for the time, but hardly to be praised in the light of modern knowledge. The wound was explored digitally by unprotected fingers three times in the first twenty-four hours, and repeatedly during the collective examination of the patient by many prominent physicians. Nonsterile probes were used during the first five days in an attempt to trace the bullet. This unhygienic treatment is probably associated with the presence of the subhepatic abscess and the abscess in the right iliac fossa. A catheter could be passed into the latter. Since there was no seeming displacement, the fractured vertebra was not suspected during life. It was fortunate that the probes were not able to trace the bullet through the vertebra, as spinal cord penetration or perforation of the already damaged splenic artery might have resulted. Surgical intervention immediately following the shooting was not indicated, since there was no evidence of visceral injury nor of actual involvement of the spinal cord. Better drainage for the abscesses might have been ultimately provided. Blood transfusions and intravenous fluid administration would have been useful, as would the antibiotics, and such treatment would undoubtedly lower the mortality risk from such a wound today.

CASE 3. W. McK., aged 58.

Shot twice, by Leon Czolgosz, anarchist, while greeting people at the Buffalo Pan-American Exposition on the afternoon of September 6, 1901. Later, a woman said that she had noticed a man near her in the reception line with what appeared to her to be his shirt cuff hanging down over his right hand. It was his handkerchief covering the pistol, which he raised as the President held out his own hand to him.

One bullet inflicted a superficial skin wound over the upper part of the sternum; the other entered the left upper quadrant of the abdomen, perforating both walls of the stomach at the greater curvature, and then, after grazing the upper pole of the left kidney, apparently buried itself in the deep muscles of the back.

The President was taken to a small emergency hospital on the Exposition ground, where, within ninety minutes of the shooting, Dr. Matthew Mann, a distinguished Buffalo surgeon, began an exploratory laparotomy. Light for the operation was provided in part by reflecting the rays of the setting sun into the wound by means of a hand mirror. The instruments used were those carried in a small pocket case by a local physician. Drop ether anesthesia was employed. The President was a large man; consequently exposure of the abdominal viscera under the conditions of the operation was not too easy. The perforations on both walls of the stomach were closed with a double row of silk sutures. Fortunately, the shooting occurred several hours after a meal, and there was little contamination of the peritoneal cavity from gastric contents. The path of the bullet into the retroperitoneal tissue was found, but, because of operative shock, the abdomen was closed without further exploration. The physicians felt confident that it was safe to do this, their only fear being the danger of septic peritonitis from leakage of the stomach contents. Dr. Mann provided no drainage, because, as he said, there was nothing to drain.

Dr. Mann was a surgeon with courage and must be admired for operating without delay, even in the absence of adequate facilities. Kocher of Berne had performed the first successful operation for gunshot wound of the stomach in 1884, just fifteen years before. Military experience in the Spanish-American and in the Boer Wars had made it customary to treat such wounds conservatively,

that is, without laparotomy. Therefore, Dr. Mann's decision to operate, though correct, was remarkable at that period.

During the first week, the President made satisfactory progress. He seemed to recover from the initial shock of the operation and was beginning to take solid food in addition to small amounts of liquids. On several occasions a little physiologic salt solution was injected under the skin. The urinary output was 270 cubic centimeters for the second day, and 420 cubic centimeters for the third day. The urine was concentrated, its specific gravity being 1.026. Dehydration was therefore probable, and the frequent irritating enemas and castor oil, given for the purpose of "elimination," did not aid in maintaining fluid balance.

At noon on September 13, the seventh day after operation, shortly after an official bulletin announcing favorable progress, the President suddenly began to fail, and in thirty-six hours he was dead.

Autopsy showed no anatomic explanation, but officially death was attributed to the presence of a localized peritonitis near the pancreas in the retroperitoneal tissue along the bullet path. The sutured holes in the stomach were still closed, and the slight wound on the upper pole of the left kidney was healing. Although no embolus was reported, some physicians thought that the sequence of events suggested pulmonary embolism. As a possible explanation it seemed to fit the meager reports of the clinical findings during the last few hours. Another explanation is that of the occurrence of a dehydration type of shock, due to frequent purging and enemas, continued fever, and small oral intake of fluids.

The autopsy also showed postoperative wound infection, with a moderate amount of pus. For this reason some sutures had been removed before death. The wound behind the stomach was the terminal track of the bullet. This area was found to be gangrenous throughout, with regional peritonitis.

Many theories were offered concerning the cause of the gangrenous bullet tract. Some people believed that it was due to a bullet poisoned with curare or smeared with virulent bacteria, but this idea was officially refuted. Others thought that there was a leakage of pancreatic juice into the bullet sinus, that the pancreas was injured and the fact not recognized at operation. Thus the conclusion was reached that the injured pancreas resulted in the digestion of the surrounding tissues. The bullet was never removed. No mention was made of the condition of the gastrorrhaphy site.

The necropsy findings aroused much criticism in regard to the surgical care. In the mind of the public doubt was raised as to the efficacy of treatment, and some people believed that the doctors had been wrong in their conception of the case. However, consensus of medical opinion sided with the surgeon, who said, "the case was a fatal one from the start." Today's treatment would, of course, include intravenous administration of fluids, use of antibiotics, and blood transfusion.

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# REVIEWS OF NEW BOOKS

THE sixth edition of *Electrotherapy and Light Therapy*[1] is divided into five parts. Part 1 deals with the subject of electrophysics; part 2 with general electrotherapy and electrodiagnosis; part 3 with light therapy; part 4 with the essentials of hydrotherapy and mechanotherapy; and part 5 with the application of applied physical therapy.

The several chapters on light therapy are well presented. The physics of infrared and ultraviolet both natural and artificial are adequately covered. In this section there is a pertinent chapter on the disinfection of air as well as the controversial subject of blood irradiation by ultraviolet.

Medical diathermy is well presented with a section devoted to heating by microwaves. Investigations are cited in which one group of workers found microwaves increased blood flow but that short wave diathermy did not; while another group showed there was no significant difference in blood flows using either method. Kovács, to account for this anomaly, postulated it might be due to the physiological responses of the body to the two distinct forms of heat. It is unfortunate indeed, that the author did not review the work of Siems who explained fully the causes of this apparent discrepancy. One also wonders how induction heating could be secured as illustrated in Figure 171.

There are two good chapters on hyperthermy and one on electrosurgery. A small but adequate discussion is given to the field of ultrasonics. There is also a timely chapter on electric injuries.

In the application of applied physical therapy one gets the impression that the author is far from conservative in his presentation, but physicians with discrimination will find this chapter of value. Its value for the immature student, however, is questionable.

In the section on electrophysics sufficient subject matter is given to enable one to understand a few of the underlying principles of electricity, although the material is not always presented with sufficient clarity. For example the author gives the impression that an electrical current is needed to cause the ions in an electrolytic solution, as he puts it, "to wander." Under these conditions ions do not wander but travel in a definite direction and with a given velocity.

The section devoted to general electrotherapy and electrodiagnosis leaves much to be desired. The author uses terms which often are either ill defined or not defined at all.

The chapter on electrophysiology is certainly oversimplified, often giving inaccurate information. It is unfortunate the author used a 10 year old edition of physiology as a reference. Marked progress has been made in the subject of electrophysiology during the past 5 years. The subject of action currents, however, is well presented not only in this section, but elsewhere in the book. The diagnostic significance of the electromyogram is well outlined.

Electrodiagnosis is a rather disappointing chapter. One is surprised to find the statement that the end result of R.D. is finally a fatty degeneration of the muscles. Too much space is devoted to Erb's test and chronaxie measurements. Both methods still have restricted use but are not nearly as valuable as the methods refined and used by Pollock and his coworkers. Under the heading of new methods of diagnosis one is surprised to find so little space given to the significant work of Pollock. He is credited with using the triangular current which Pollock no longer uses. The reviewer feels that this section should have included at least a discussion of such electrodiagnostic tests as the use of repetitive square wave stimuli, and the galvanotetanus ratio. In discussing the strength-duration test the writer states that commercial apparatus is not available for making the test. Fortunately, this is not so. The Council on Physical Medicine of the American Medical Association lists approval of at least one such apparatus, namely the Golseth-Frizell Constant Impulse Stimulator, by means of which all the tests mentioned in this review may be obtained.

In the chapter on low frequency currents Dr. Kovács states the requisite treatment for denervated muscle is to secure contraction with comfort. He fails to mention the most important factor namely that the muscle must be made to contract with tension. Contraction without tension is practically useless therapy. Again the author states that the motor point of the denervated muscle is displaced distally. If the muscle is denervated, how can there be a motor point?

Dr. Kovács is considered one of the leading exponents of the art of physical medicine and for that reason, his writings carry a great deal of influence. He has had a wide experience as a teacher, writer, and practitioner of physical medicine and it is, therefore, somewhat disappointing to find this book does not fully measure up to the standard one should be led to expect.

STAFFORD L. OSBORNE.

THE author of *A Manual of Physical Therapy*[2] states in his preface that this volume is based in part on the material taught for many years at postgraduate courses for physicians and nurses at the New York Polyclinic Medical School and Hospital.

[1] ELECTROTHERAPY AND LIGHT THERAPY; WITH ESSENTIALS OF HYDROTHERAPY AND MECHANOTHERAPY. By Richard Kovács, M.D. 6th rev. ed. Philadelphia: Lea & Febiger, 1949.

[2] A MANUAL OF PHYSICAL THERAPY. By Richard Kovács, M.D. 4th rev. ed. Philadelphia: Lea & Febiger, 1949.

The plan of the book is to proceed from a brief exposé of the basis and the evolution of physical therapy to the systematic presentation of the physics, physical and physiological effects, clinical uses, technique of application, dangers and contraindications of each of the principal physical treatment methods. A new chapter on rehabilitation has been added. The volume is divided into six parts: an introduction, heat and light, electricity, water, massage, and exercise, and applied physical therapy.

The first two sections are well presented and make an excellent skeleton for classroom teaching. The subject of electrophysics is concisely written and adequate.

It is to be regretted that Dr. Kovács uses the terms "ion transfer" and "iontophoresis" synonymously. A textbook such as this needs to make clear the differences in these terms. The writer defines ionization quite lucidly. It is unfortunate this section was not taken verbatim from his larger textbook.

He uses the term electrolysis with exactitude but then without explanation reverts to the archaic term of surgical galvanism.

In the chapter on electrodiagnosis too much space is devoted to Erb's test and chronaxie measurements and not enough to the new methods now in use. Some of the new tests are not mentioned. Electromyography is dismissed with a paragraph.

There is a brief but adequate chapter on high frequency currents for the novice.

The author gives considerable space to the hydroelectric bath but one wonders what are the benefits beyond a regular full tub bath. The device illustrated for this procedure has not been approved by the Council on Physical Medicine.

Some space is given to hypothermy and colonic irrigation. An excellent chapter on exercise is contributed by Dr. Madge McGuinness. There is also a very useful chapter on physical therapy in institutional practice as well as one on medical rehabilitation.

This manual is rather advanced for use in a regular school of nursing. It will be found a useful adjuvant to any course of electrotherapy provided the instructor is well grounded in the subject so that the student may be guided intelligently through some of its murky regions. STAFFORD L. OSBORNE.

A NEW book by C. F. M. Saint of South Africa entitled *An Introduction to Clinical Surgery*[1] is one which every medical student should own and one that every practitioner of medicine and surgery would feel proud to have in his library. It is essentially an exhaustive treatise on clinical diagnosis and has little or nothing to do with treatment. Its main object is to teach methods of diagnosis based on reasoned thinking, and it is the result of the author's many years of practical experience as a surgeon and teacher.

The book covers a discussion of the following subjects: note taking; injuries; inflammations; tumors and swellings; abdominal emergencies; stomach and duodenum; appendicitis; rectal cases; hernia; scrotal swellings; diseases of the urinary tract; calculi; swellings of the breast; fractures; diseases of the long bones; diseases of the joints; diseases of the tongue; injuries of the head; swellings of the thyroid gland; jaundice; lung conditions; peripheral vascular disease; and swellings of the neck.

Each ot these subjects is taken up in the following manner: Each discussion begins with a most carefully written history, going into the minutest detail. Then follows the general physical examination and local examination (making the most exhaustive use of the information gained by inspection, palpation, percussion, and auscultation), the special examination (including all laboratory data and x-ray findings), and, finally, a concise discussion of the differential diagnosis. At the close of each chapter are shown a group of very good black and white photographs of patients, gross pathological specimens, illustrative drawings, and well chosen x-ray pictures.

I personally am very much pleased to have this book close at hand at my desk for reference, as a valuable aid in the teaching of my students, and as a helpful guide when difficult problems in diagnosis arise. EDWIN M. MILLER.

THE author and publisher of Volume 19 of the *Annals of Roentgenology*[2] have provided a most promising textbook on the roentgenological diagnosis of intracranial lesions. The illustrations, in the negative, are really outstanding and very nicely reproduced. Only one who has attempted to provide a publisher with satisfactory copy for illustrations can realize the enormous amount of work which must have gone into the preparation of the roentgenographic copy for the illustrations. The author has emphasized the necessity for close co-operation between the clinical and roentgen departments, and for this reason the book is addressed to the neurologist, the neurosurgeon, and to other clinicians as much as to the radiologist. JAMES T. CASE.

ALL types of abdominal herniation with special reference to etiology, signs and symptoms, and methods of treatment are discussed in the 395 page book, *The Surgery of Abdominal Hernia*[3] by George B. Mair. One hundred and thirty-eight illustrations are included. An imposing collection of references from the literature are used to support the author's

[1] AN INTRODUCTION TO CLINICAL SURGERY; SURGICAL WHEREFORES AND THEREFORES; A REASONED EXPLANATION OF SURGICAL NOTE-TAKING. By Charles F. M. Saint, C.B.E., M.D., M.S., F.R.C.S.(Eng.), Hon. F.R.A.C.S., Hon. F.G.S.S. Cape Town and Johannesburg: (Published for The Post-Graduate Press) Juta & Co., Ltd., 1949.

[2] ANNALS OF ROENTGENOLOGY; A SERIES OF MONOGRAPHIC ATLASES. ROENTGEN DIAGNOSIS OF DISEASES OF THE SKULL. Vol. 19. By Max Ritvo, M.D. Foreword by George W. Holmes, M.D. New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1949.

[3] THE SURGERY OF ABDOMINAL HERNIA. By George B. Mair, M.D., F.R.F.P.S.G., F.R.C.S.E. Baltimore: The Williams & Wilkins Co., 1948.

contention that the Bassini repair and its various modifications are unsatisfactory.

Indirect inguinal hernia is repaired by high ligation and excision of the sac. This is followed in those cases requiring it by reinforcement of the weakened areas with full thickness skin grafts. Some 23 pages are devoted to summarizing the literature and the author's investigative work, both animal and clinical, on this type of repair. Cutis grafts are briefly discussed. Direct inguinal hernias, ventral hernias, umbilical and incisional hernias are treated by the usual methods and then reinforced by a skin graft. Fascial sutures are believed to be more effective than the Bassini repair but less so than the skin graft.

Most American surgeons would place more stress on the use of penicillin and streptomycin in the treatment of strangulated hernia. The short supply in Britain may account for this difference.

The use of Cooper's ligament in inguinal hernia repair as advocated by McVey has recently received considerable favorable comment in this country but is not mentioned in the text.

The monograph is stimulating and well written. Possibly the use of cutis or skin grafts which are as yet too new to be properly evaluated will in time become established as an additional tool for the repair of some difficult hernias. The wide divergence of opinion on the subject of hernia repair which is presented should serve to make all surgeons more critical of their own results. THOMAS C. DOUGLASS.

THE second edition of *Atlas of Surgical Operations*[1] follows the same pattern as did the first, published 10 years ago. It is more nearly complete in that descriptions of 30 operations have been added to the procedures illustrated in the first edition.

The first part of the book contains a few pages devoted to the importance of meticulous surgical technique, the choice of anesthetic agents and their methods of administration and perhaps too brief a discussion of preoperative and postoperative care of patients. Operations commonly performed are presented in clearly executed line drawings which call attention, step by step, to the important features of the procedures. Descriptive text matter appears opposite each full page of drawings.

The book should be helpful to medical students and young surgeons, all of whom should know that no amount of time consumed in the study of any such manual can in any way supplant the painstaking years of training necessary for the acquisition of proper surgical technique. ROLLIN A. DANIEL, JR.

MODERN surgical concepts are more than adequately interpreted in *A Short Practice of Surgery*.[2] One of the main reasons for the popularity of this text of general surgery is the manner of presentation of the material which is at the same time both concise and precise.

The content is certainly not lacking in vitality, due mainly to the absence of excess words. Presented with a form of literary expression which definitely belongs to the present era of surgery, the content is not difficult to grasp and is invested with purposeful meaning, yet manages not to be narrowly conventional and certainly not monotonous.

Special care has been exercised in the makeup of the pages and the use of illustrations which are used plentifully with the thought of "one picture is worth a thousand words." The illustrations are utilized not as mere artificial devices but rather to stimulate and re-enforce the text.

The authors have managed to bring together the most fitting of the problems of modern day surgical experience and practice. The approach is such that the impracticalities of a pure academic point of view are avoided, and because of this the compensations are many. ORVILLE F. GRIMES.

THE second edition of *Physiology of the Uterus*[3] by S. R. M. Reynolds is an excellent contribution to the gynecologic and obstetric literature. This monograph written by a physiologist deals with the fundamental work in this field. The material is presented from the viewpoint of the trained investigator. Conflicting data are frequently recorded. A real attempt is made to point out the practical application of the physiologic observations made. This monograph will be of great value to the serious student of obstetrics because it will give him an academic understanding of the functioning of the uterus. From this basic knowledge he will realize why many of the clinical procedures are not empirical but based on sound knowledge. The research student will also find this a comprehensive volume with an excellent bibliography.

The second edition has been completely revised. The organization has been changed. The subject matter has been treated in large sections, each containing a sequence of closely related chapters. New chapters on human tocography, steroid hormones during pregnancy, factors in abnormal uterine growth, myometrial forces in relation to uterine growth and parturition, vasculature of the uterus, uterine vascular adaptations to pregnancy, and maternal-fetal relationships and placental exchange have been added which increase the scope of the book.

The book rightly starts with a chapter on the morphology of the uterus with a short section on embryology so that the patterns discussed next can be understood. The same fundamental patterns of uterine and tubal motility have been found in all the mammallian forms studied. During estrus the activity of the tubes seems to be the chief governing influence over the activity of the uterus. The func-

[1] ATLAS OF SURGICAL OPERATIONS. By Elliott C. Cutler and Robert M. Zollinger. Illustrated by Mildred B. Codding. 2d ed. New York: The Macmillan Co., 1949.

[2] A SHORT PRACTICE OF SURGERY. By Hamilton Bailey, F.R.C.S.(Eng.), F.A.C.S., F.I.C.S., F.R.S.E., and R. J. McNeill Love, M.S.(Lond.), F.R.C.S.(Eng.), F.A.C.S., F.I.C.S. 8th ed. Baltimore: The Williams & Wilkins Co., 1949.

[3] PHYSIOLOGY OF THE UTERUS. By S. R. M. Reynolds, M.A. Ph.D. 2d rev. enl. ed. New York: Paul B. Hoeber, Inc., 1949.

tion of tubal and uterine motility in causing migration of spermatozoa and transport of ova is discussed. Recent work by Woodbury on uterine motility suggests that the cause of dysmenorrhea may be due to disorganized contractions with failure of outward propulsion of uterine contents. The work of Knaus on the estimation of the time of ovulation seems to be substantiated by other observers.

The second part of the book relates to the hormone control of the myometrium, its activation by the estrogens, and inactivation by progesterone. This section on the influence of the steroid hormones on nidation, ovulation, tubal migration, pregnancy, and parturition is well done.

The material in the third part on uterine growth deals with mechanical problems involved in increase in the size of the uterus. There is a chapter on the factors influencing abnormal uterine growths such as fibroids and growths of the endometrium. The role of the spinal arterioles—their development, their increase in coiling premenstrually—is well illustrated and described. The recent work of Reynolds on uterine accommodation has shown that after the initial period of preparation there is extensive progestional proliferation. As the embryo increases in size, the uterus assumes a spheroid shape, since at first the embryo is a spheroid, but as the conceptus changes to a cylindrical form, new hydrostatic conditions result in longitudinal distention of the uterus.

One of the best sections of the book is that on circulation in the uterus. This has been an interesting field since Markee's investigations on the phenomena of menstruation in the intraocular endometrial transplants in the rhesus monkey. The estrogen levels seem to be the factor that determines vascular development; lack of it causes degenerative changes. Menstruation may be the result of a shift in a delicately adjusted balance between the supply or withdrawal of this growth-promoting stimuli.

In the section on innervation of the uterus, the extrinsic connection of the sympathetic nerves through the pelvic nerves is described as is the intrinsic nerve supply to the uterus. The second chapter in this section deals with what is known of the role the previously described nerves play in the sensory and motor functions of the uterus.

This is an excellent book; the author has completely covered a large and difficult subject.

FRANCIS M. INGERSOLL.

THE invaluable experience which Ernest Sachs has collected during a life devoted to neurological surgery has been combined in one volume.[1] This material had been previously published in two separate volumes: *The Diagnosis and Treatment of Brain Tumors* (1931) and *The Care of the Neurosurgical Patient, before, during and after Operation* (1945). This vast subject has been divided into fifteen clear, well outlined, and concise chapters. They include outlines and discussions of the surgical anatomy and physiology of the brain, methods of neurological and neurosurgical examination, surgical pathology of brain tumors, general symptoms and signs of increased intracranial pressure, focal signs and symptoms of tumors of the cerebrum, cerebellum, pons and medulla, diseases of the pituitary gland, differential diagnosis between brain tumors and other conditions such as abscess, aneurysm, meningitis, uremia; operative technique and methods; and postoperative care. Each subject is illustrated by concise résumés of typical case histories and beautiful reproductions of roentgenograms of the skull, ventriculograms, photographs of patients, and macroscopic and microscopic specimens.

The author's great experience, sound principles, and human understanding of the patient's condition and feelings shine through every page and create sympathy for the author, his often depressing work, and his patients. He emphasizes that "... malignant tumors of the brain should be operated upon and attempt made to remove them completely, ... for a patient is entitled to temporary relief even if he cannot be permanently cured ...."

This 552 page book contains 348 illustrations and 10 color plates. It will be invaluable to students and general practitioners as well as to the young neurosurgeon who needs help and encouragement and the advice of a good and wise man. GEORGE PERRET.

FEW books have been written on the subject of therapeutic exercise. None are adequate and Kraus' *Principles and Practice of Therapeutic Exercises*[2] is no exception although the author has made a fundamental and correct approach to the subject.

The book is divided into three parts. Part 1 deals with fundamental working principles such as the clinical pathophysiology of exercises, measurements, exercise techniques, treatment of pain, and the exercise and supportive prescription. The application of therapeutic exercises to particular fields such as posture, back pain, fractures, joint lesions, and lesions of the nervous system are outlined in part 2. Part 3 is related to the problems of general exercise with particular attention given to the presurgical and convalescent patient.

The text lacks clarity and is often ambiguous. One gains the impression of superficiality and oversimplification of many important points. Many statements are too dogmatic. The author states the book is intended for newcomers to the field of therapeutic exercise, but this is not a book for the novice. Certainly the writer's casual definitions of spasm, spasticity, "hypertenseness," and rigidity would not satisfy the neuroanatomist, physiologist, or clinical neurologist. In fact the definitions are vague, confusing, and contradictory.

The use of the term "de-contraction" would seem to be ill chosen, as a substitute for Sherrington's concept of the reciprocal inhibition of muscles.

[1] DIAGNOSIS AND TREATMENT OF BRAIN TUMORS AND CARE OF THE NEUROSURGICAL PATIENT. By Ernest Sachs, A.B., M.D. 2d ed. St. Louis: The C. V. Mosby Co., 1949.

[2] PRINCIPLES AND PRACTICE OF THERAPEUTIC EXERCISES. By Hans Kraus, M.D. Springfield, Ill.: Charles C Thomas, 1949.

It is not clear why the author prefers to use novocain "iontophoresis" (ion transfer) for the relief of pain instead of the usual hypodermic method.

According to Kraus weight loss of the denervated muscle can be retarded by massage but according to the best available evidence this cannot be substantiated. He also writes superficially of motor point stimulation by an electric current to produce artificial exercise when the muscle is unable to respond voluntarily. If the author really means the denervated muscle then of course there can be no such motor point. Unless attention is given to the current form and duration of stimulus, such stimulation is ineffective.

In spite of the above criticisms the book has a great deal of merit. The author has approached the problem from the proper viewpoint. The subject matter is well outlined and an experienced physiatrist or physical therapist will find a great deal of valuable information. For teachers of therapeutic exercise it should prove to be a valuable guide for presenting this difficult subject. Its value as a textbook per se, however, is doubtful. The author has consulted many books and articles and gives them in the form of an excellent bibliography at the close of the volume. It is unfortunate that Kraus does not indicate when he is making reference to some particular author. It would have been more helpful to the reader if the source of the references consulted were placed in a footnote of the page where the references were made.

This book is of value to those physiatrists and physical therapists who have had considerable clinical experience in therapeutic exercise.

STAFFORD L. OSBORNE.

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# BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

GYNAECOLOGY. By Herbert H. Schlink, Clement L. Chapman, George G. G. L. Stening, and Frederick N. Chenhall, Sydney, London: Angus and Robertson, 1949.

LES ICTÈRES MOYENS D'EXPLORATION, SYMPTOMES PHYSIOPATHOLOGIE, THÉRAPEUTIQUE. By I. Pavel. 3d ed. Paris: Masson et cie, 1949.

PRINCIPLES OF HUMAN GENETICS. By Curt Stern. San Francisco: W. H. Freeman & Co., 1949.

HARVEY CUSHING; SURGEON, AUTHOR, ARTIST. By Elizabeth H. Thomson. New York: Henry Schuman, 1950.

TENSOPLAST TECHNIQUE; A CLASSIFIED REFERENCE TO THE USES OF TENSOPLAST IN MODERN SURGERY. 1st ed. Hull, London, Glasgow, Manchester: T. J. Smith & Nephew, Ltd., 1939.

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SURGERY FOR NURSES. By James Moroney, M.B., Ch.B., F.R.C.S.(Eng.), L.R.C.P.(Lond.). Baltimore: The Williams & Wilkins Co., 1950.

LIPIDOSES; DISEASES OF THE CELLULAR LIPID METABOLISM. By Siegfried J. Thannhauser, M.D., Ph.D. Edited by Henry A. Christian, M.D. New York: Oxford University Press, 1950.

A NEW APPROACH TO THE TREATMENT OF BURNS AND SCALDS. By Leonard Colebrook, F.R.S., F.R.C.O.G. London: Fine Technical Publications, 1950.

WOMAN'S SURGEON; THE LIFE STORY OF J. MARION SIMS. By Seale Harris, M.D. New York: The Macmillan Co., 1950.

MODERN MEDICINE ANNUAL 1950. Minneapolis: Modern Medicine, 1950.

PARKINSON'S DISEASE. By Walter Buchler. Norwich and London: Fletcher and Son Ltd., and the Leighton-Straker Bookbinding Co., Ltd., 1950.

PENICILLIN AND STREPTOMYCIN IN THE TREATMENT OF INFECTIONS. By Chester S. Keefer, M.S., M.D., Sc.D. (Hon.), Donald G. Anderson, M.D., and Henry A. Christian, A.M., M.D., LL.D., Sc.D. (Hon.), M.A.C.P., Hon. F.R.C.P.(Can.), D.S.M. (A.M.A.). 2d ed. New York: Oxford University Press, 1950.

NURSING CARE OF THE SURGICAL PATIENT. By John Pettit West, M.D., Manelva Wylie Keller, B.S., R.N., and Elizabeth Harmon, B.A., R.N. 5th ed. New York: The Macmillan Co., 1950.

GELFAND SCHISTO-SOMIASIS IN SOUTH CENTRAL AFRICA; A CLINICO-PATHOLOGICAL STUDY. By Michael Gelfand, M.D., M.R.C.P. Cape Town and Johannesburg: (For the Post Graduate Press) Juta & Co., Ltd., 1950.

THE MANAGEMENT OF THE PATIENT WITH SEVERE BRONCHIAL ASTHMA. By Maurice S. Segal, M.D. Springfield. Ill.: Charles C Thomas, 1950.

CHIRURGIE DER UROGENITALORGANE; INDIKATION UND TECHNIK. By Prof. Dr. H. Boeminghaus. Vols. 1, 2, and 3. Bad Worishofen, Germany: Werk-Verlag Dr. Edmund Banaschewski, 1950.

AMPUTATION PROSTHETIC SERVICE. By Earle H. Daniel. Baltimore: The Williams & Wilkins Co., 1950.

THE CAUSATION AND TREATMENT OF DELAYED UNION IN FRACTURES OF THE LONG BONE. By Kenneth W. Starr. London: Butterworth & Co., Ltd.; St. Louis: The C. V. Mosby Co., 1947.

RELAXATION AND EXERCISE FOR NATURAL CHILDBIRTH. By Helen Heardman. Baltimore: The Williams & Wilkins Co., 1950.

ANNUAL REVIEW OF MEDICINE. Windsor C. Cutting, Editor and Henry W. Newman, Associate Editor. Vol. 1. Stanford, Calif.: Annual Reviews, Inc., 1950.

CYTOLOGIC DIAGNOSIS OF LUNG CANCER. By Seymour M. Farber, M.D., Milton Rosenthal, M.D., Edwin F. Alston, M.D., Mortimer A. Benioff, M.D., and Allen K. McGrath, Jr., M.D. Springfield, Ill.: Charles C Thomas, 1950.

SEX WITHOUT FEAR. By S. A. Lewin, M.D., and John Gilmore, Ph.D. New York: Lear Publishers, 1950.

THE ETHICAL BASIS OF MEDICAL PRACTICE. By Willard L. Sperry. New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1950.

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

FREDERICK A. COLLER, Ann Arbor, *President*
HENRY W. CAVE, New York, *President-Elect*

## PRELIMINARY PROGRAM FOR THE 36th CLINICAL CONGRESS—HOTEL STATLER, BOSTON OCTOBER 23 TO 27, 1950

WITH hotel headquarters at The Statler and the Copley-Plaza, the thirty-sixth Clinical Congress of the American College of Surgeons will be held in Boston from October 23 to 27, 1950. An extensive and varied program of meetings, clinics, exhibits, films, and color television is planned. A report of progress was presented to the Board of Regents by Dr. Thomas H. Lanman, chairman of the Boston Committee on Arrangements, at its meeting in Colorado Springs on April 21. Visiting surgeons will have every opportunity to obtain first hand information on a wide variety of surgical and related subjects, and hospital representatives will have an interesting series of conferences on current hospital problems.

### COLOR TELEVISION

Color telecasts of surgical procedures at Massachusetts General Hospital will be shown daily during the Clinical Congress. The television will unquestionably be a great attraction at the 1950 Congress, as it has been at the last three meetings in New York, Los Angeles, and Chicago.

### HOSPITAL CLINICS

Under the leadership of the Committee on Arrangements, and the hospital representatives, a program of operative and nonoperative clinics is being arranged in 25 hospitals, as a major feature of the Clinical Congress. The schedules of clinics, which will cover general surgery, obstetrics and gynecology, fractures and other trauma, neurosurgery, orthopedic, thoracic, and genitourinary surgery, and ophthalmology and otorhinolaryngology, will be published in a *Daily Clinical Bulletin* which will be issued each day during the Clinical Congress. The clinic schedules will also be posted on bulletin boards.

### PRESIDENTIAL MEETING AND CONVOCATION

Dr. Frederick A. Coller of Ann Arbor, the retiring President, will deliver the Presidential Address at the Presidential Meeting on Monday evening. At the same session Dr. Henry W. Cave of New York will be installed as President, and Dr. Warren H. Cole of Chicago and Dr. G. Gavin Miller of Montreal as First and Second Vice President respectively. The fifth Martin Memorial Lecture will be delivered by Mr. Geoffrey Jefferson, C.B.E., F.R.C.S.(Eng.). Dr. Coller's and Mr. Jefferson's subjects will be announced later.

The annual Convocation which includes formal initiation ceremonies for the new Fellows will take place on Friday evening, October 27, probably in Symphony Hall. The Fellowship Address will be given by Dr. Paul R. Hawley, Director of the College. His subject will be "Quo Vadimus."

### MEETINGS OF THE BOARD OF GOVERNORS AND FELLOWS

The Board of Governors of the College will convene with luncheon on Monday and will meet from 12:45 to 5:00 p.m. Any unfinished business will be discussed at a session on Wednesday morning. There will be an adjourned meeting at 3:00 p.m. on Thursday.

The Governors will act as a clearing house for the Board of Regents on general assigned subjects and on local problems. They are being apprised of the actions taken by the Board of Regents and will aid in interpreting these actions to the Fellows.

The Annual Meeting of Fellows will be held on Thursday afternoon at 3:15. The agendum in brief follows:

Election of Officers and Governors of the College
Report of the Treasurer
Report of the Cancer Committee
Report of the Committee on Trauma
Report of the Committee on Graduate Training in Surgery
Report of the Committee on Medical Motion Pictures
Report of the Director on the College Program
General Discussion (30 minutes)

### COMMITTEE ON ARRANGEMENTS

The Boston Committee on General Arrangements for the Clinical Congress is composed of the following Fellows:

*Thomas H. Lanman, *Chairman*
*Donald Munro, *Vice-Chairman*
*Orvar Swenson, *Secretary*
*Arthur W. Allen, *Chairman*, Board of Regents

Edwin W. Cave
Edward D. Churchill
Fletcher H. Colby
Edwin B. Dunphy
*J. Englebert Dunphy
Henry H. Faxon
Robert E. Gross
Frank H. Lahey
Charles C. Lund
Leland S. McKittrick
Henry C. Marble
Joe Vincent Meigs
Charles G. Mixter
Francis D. Moore
William R. Morrison
*Langdon Parsons
Walter G. Phippen
Duncan E. Reid
LeRoy A. Schall
Reginald H. Smithwick
Grantley W. Taylor
*C. Stuart Welch

*Executive Committee

Boston was host to the Clinical Congresses of 1915, 1922, 1928, 1934, and 1941. Notable contributions to surgical and medical knowledge were made at these meetings. Those who attend in 1950 may anticipate a program of broad scope and interest, for the surgeons of Boston have complete facilities at their command in the three medical schools and more than thirty approved hospitals in Boston and vicinity.

### GENERAL, PROGRAM, AND PUBLIC RELATIONS COMMITTEES

The Clinical Congress General Committee consists of Dr. Paul R. Hawley, Chairman, Eleanor K. Grimm, Secretary, Dr. Charles F. Branch, Laura G. Jackson, Dr. George H. Miller, Edward G. Sandrok, Dr. H. Prather Saunders, and James S. Shannon.

The Clinical Congress Committee on Programs consists of Dr. Frederick A. Coller, Chairman, and Doctors Henry W. Cave, Evarts A. Graham, and Alton Ochsner. Programs for the specialties are being arranged in co-operation with the Advisory Council of the College on ophthalmology, otorhinolaryngology, neurological surgery, obstetrics and gynecology, orthopedic surgery, thoracic surgery, and urology.

The Advisory Committee on Programs consists of Dr. George H. Miller, Chairman, and Doctors Warren H. Cole, Sumner L. Koch, Michael L. Mason, Charles B. Puestow, Paul R. Hawley, H. Prather Saunders, Charles F. Branch, and Malcolm T. MacEachern.

The Public Relations Committee consists of Dr. Charles B. Puestow, Chairman, members of administrative staff, American College of Surgeons, and members of the local committee on publicity.

### EVENING SCIENTIFIC SESSIONS

Eminent surgeons and specialists, recognized as authorities in their fields, will address the scientific meetings which will be held on Tuesday, Wednesday, and Thursday evenings. The preliminary program for the general surgery sessions follows:

#### *Tuesday, October 24*

The Concept of the General-Adaptation-Syndrome as Applied to Surgical Problems (with Special Emphasis upon Cortisone and ACTH). HANS SELYE, Montreal.
Biophysics in Surgery. AMBROSE STORCK, New Orleans.
The Principles Involved in the Clinical Use of Streptokinase-Streptodornase. WILLIAM S. TILLETT, New York.

#### *Wednesday, October 25*

Fracture Oration. (Selected by Committee on Trauma).
Intravenous Fat Feeding. FREDERICK J. STARE, Boston.
The Neurological Complications of Spinal Anesthesia. R. D. DRIPPS, Philadelphia.

#### *Thursday, October 26*

Lobotomy Versus Other Operations for the Relief of Pain. JAMES C. WHITE, Boston.
The Etiology and Treatment of Hirschsprung's Disease. ORVAR SWENSON, Boston.
Late Surgical Complications Following Irradiation of Pelvic Viscera. WILLIAM CRAWFORD WHITE, New York.

On Tuesday and Thursday evenings, there will be separate sessions for Ophthalmology and for Otorhinolaryngology. The Wednesday evening meeting will be a joint ophthalmology and otorhinolaryngology session with the New England Otolaryngological Society participating. A preliminary outline of the programs follows:

#### *Tuesday, October 24, Ophthalmology*

Ocular Effects of the Atomic Bomb in Japan
Evaluation of Retinal Vascular Diseases
Treatment of Pigmented Tumors of the Eye

#### *Tuesday, October 24, Otorhinolaryngology*

Modern Bacteriology as an Aid to the Otolaryngologist
The Influence of Fundamental Concepts in Allergy upon Specific Problems in Otolaryngology
The Present Status of the Relationship of Tonsillectomy to Poliomyelitis

*Wednesday, October 25*
*Joint Session*

Antibiotics Today. CHESTER S. KEEFER, Boston.
Ophthalmological Applications of the Newer Antibiotics. IRVING H. LEOPOLD, Philadelphia.
Use of Antibiotics in Otolaryngology. FRANCIS W. DAVISON, Danville, Pennsylvania.

*Thursday, October 26, Ophthalmology*

Glaucoma after Cataract Extraction
Present Trends of Surgery of the Oblique Muscles
End Results of Integrated Implants in the Orbit

*Thursday, October 26, Otorhinolaryngology*

Symposium on Tumors of the Nose and Sinuses:
Symptomatology
X-ray Diagnosis
Preparation and Care of the Mouth of the Patient Receiving X-ray Therapy about the Head and Neck
Treatment by a Combination of Surgery and Radiation

AFTERNOON PANEL DISCUSSIONS, GENERAL SURGERY

General surgery panel discussions will be held Monday through Thursday afternoons from 1:30 to 3:00 o'clock, and Monday through Wednesday afternoons from 3:30 to 5:00 o'clock. A preliminary outline follows:

*Monday*

1:30–3:00. Transthoracic Approach to Subdiaphragmatic Lesions. Moderator: B. NOLAND CARTER, Cincinnati.
3:30–5:00. Cancer of the Uterus. Moderator: JOHN C. BURCH, Nashville.

*Tuesday*

1:30–3:00. Anesthesia. Moderator: WESLEY BOURNE, Montreal.
3:30–5:00. Reconstructive Surgery of the Hand. Moderator: HENRY C. MARBLE, Boston.

*Wednesday*

1:30–3:00. Surgical Treatment of Congenital Anomalies of the Digestive Tract. Moderator: LAWRENCE CHAFFIN, Los Angeles.
3:00–5:00. Pitfalls in Surgery of the Gallbladder and Biliary Ducts. Moderator: WALTMAN WALTERS Rochester, Minnesota.

*Thursday*

1:30–3:00. Acute, Nontraumatic Conditions in the Abdomen. Moderator: FRED W. RANKIN, Lexington, Kentucky.

AFTERNOON PANEL DISCUSSIONS, OPHTHALMOLOGY AND OTORHINOLARYNGOLOGY

Ophthalmology and otorhinolaryngology panel discussions will be held Tuesday, Wednesday, and Thursday afternoons, in accordance with the following outline:

*Tuesday*

1:30–3:00. Chiasmal Syndrome
3:30–5:00. The Pre-School Deaf Child

*Wednesday*

1:30–3:00. Diagnosis of Orbital Tumors
3:00–5:00. What We Have Learned about Fenestration for Otosclerosis

*Thursday*

1:30–3:00. Selection of Operative Technic in Retinal Separation
3:30–5:00. The Management of the Vertiginous Patient

AFTERNOON PANEL DISCUSSIONS, SURGICAL SPECIALTIES

Friday afternoon will be devoted to panel discussion sessions for six special fields of surgery. A preliminary outline of the programs follows:

*Urology*—Moderator, THOMAS D. MOORE, Memphis.
1:30–3:00. Injuries of the Ureter
3:15–4:45. Congenital Anomalies of the Lower Urinary Tract
*Plastic Surgery*—Moderator, JAMES BARRETT BROWN, St. Louis.
1:30–3:00. Plastic Surgical Repair of Radiation Lesions
3:15–4:45. Military Plastic Surgery
*Neurological Surgery*—
1:30–3:00. Moderator, BRONSON RAY, New York. Surgical Relief of Intractable Pain
3:15–4:45. Moderator, JOHN E. SCARFF, New York. Evaluation of the Results of Surgical Procedures Undertaken for the Relief of Psychoses
*Thoracic Surgery*—
1:30–3:00. Moderator, HERBERT C. MAIER, New York. Postoperative Pulmonary Complications
3:15–4:45. Moderator, FRANK B. BERRY, New York. Trauma of the Chest and Upper Abdomen
*Gynecology and Obstetrics*—Moderator, FREDERICK H. FALLS, Chicago.
1:30–3:00. Indications for Abdominal Total Hysterectomy for Non-malignant Uterine Pathology
3:45–5:45. The Management of Urinary Incontinence in Women
*Orthopedic Surgery*—Moderator, G. EDMUND HAGGART, Boston.
1:30–3:00. The Management of Fractures and Dislocations of the Dorsal and Lumbar Spine
3:15–5:45. Fractures of the Elbow Region in Children

FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

The Forum on Fundamental Surgical Problems will be held again in 1950 to give special opportunity for the presentation of the newest discoveries resulting from research, particularly by the younger surgeons. Brief reports of original clinical and experimental observations relating to the broad aspects of surgery and the surgical specialties will be given.

SYMPOSIA ON CANCER AND ON TRAUMA

Because of the widespread interest in these special fields, a Symposium on Trauma is being ar-

ranged for one afternoon, and a Symposium on Cancer for another afternoon. There will be a Symposium on Amputees on Tuesday morning.

### MEDICAL MOTION PICTURE PROGRAM

The Medical Motion Picture Committee is now choosing films which are to be shown at the Clinical Congress. Films that have been recently produced should be forwarded to the College for immediate review as it is the policy to include in the Clinical Congress program only those films which were submitted in time to obtain approval by the Committee on Medical Motion Pictures.

### HOSPITAL CONFERENCES

The twenty-ninth Hospital Standardization Conference will convene during the Clinical Congress. Hospital administrators, trustees, members of medical staffs, nurses, technicians, dietitians, and heads of the various hospital departments and their personnel, are invited to participate.

### EXHIBITS

Mechanics Hall will house the extensive exhibit of medical and hospital supplies and equipment, television and medical motion picture showings, registration for surgeons and hospital representatives, and a few of the sessions. Leading manufacturers of surgical equipment and instruments, sutures, dressings, pharmaceuticals, and supplies of all kinds, and publishers of medical books will be represented in the exhibition.

### HOSPITALS AND HOSPITAL REPRESENTATIVES

The hospitals which will arrange clinics for the 1950 Clinical Congress, and the names of the hospital representatives, follow:

Beth Israel Hospital—Dr. Howard A. Frank
Boston City Hospital—Dr. J. Edward Flynn
Boston Lying-In Hospital—Dr. Paul Gustafson
Carney Hospital—Dr. John J. Todd
Chelsea Naval Hospital—Dr. Henry W. Hudson
Children's Medical Center—Dr. William A. Elliston
Cushing Veterans Administration Hospital—Dr. Henry Faxon
Faulkner Hospital—Dr. Marshall K. Bartlett
Free Hospital for Women—Dr. Christopher J. Duncan
Malden Hospital—Dr. Clement Lynch
Massachusetts Eye and Ear—Ophthalmology—Dr. Henry A. Mosher
Massachusetts Eye and Ear—Otorhinolaryngology—Dr. Francis L. Weille
Massachusetts General Hospital—Dr. Howard Ulfelder
Massachusetts Memorial Hospital—Dr. George Whitelaw
Mount Auburn Hospital, Cambridge—Dr. Joseph Tartakoff
New England Baptist Hospital—Dr. Herbert D. Adams
New England Center Hospital—Dr. Wyland Leadbetter
New England Deaconess Hospital—Dr. Herbert D. Adams
New England Deaconess Hospital—Palmer Memorial Unit—Dr. Clifford Franseen
New England Hospital for Women and Children—Dr. Felicia Banas
Newton-Wellesley Hospital, Newton Lower Falls—Dr. Richard I. Smith
Peter Bent Brigham Hospital—Dr. Thomas B. Quigley
Pondville Hospital, Walpole—Dr. Richard Wallace
Robert Breck Brigham Hospital—Dr. Theodore A. Potter
St. Elizabeth's Hospital—Dr. John Spellman
Veterans Administration Hospital—West Roxbury—Dr. Frederick Ross

### ADVANCE REGISTRATION

Surgeons who wish to attend the Clinical Congress should register in advance. Advance registration will greatly expedite the procedure of registering. No registration fee will be charged Fellows whose dues are paid to December 31, 1949. For endorsed Junior and Senior Candidates, the fee will be $5.00. Non-Fellows who after individual consideration are permitted to register, will pay a fee of $10.00. No registration fee will be required of initiates of the class of 1950.

### HOTEL RESERVATIONS

It is desirable to make hotel reservations as early as possible. In making these, communications should be addressed to the Convention Bureau of the Boston Chamber of Commerce, 80 Federal Street, Boston 10, which will start booking reservations on June 1. It is important that you state you will be attending the Clinical Congress of the American College of Surgeons. All hotel reservations, both for surgeons and hospital representatives, are to clear through the Convention Bureau. No correspondence should be sent directly to the hotels. A form for reservations will be enclosed in a letter to Fellows. Choice of hotels may be designated.

In addition to the headquarters hotels, the Statler and Copley-Plaza, there are a number of first-class hotels within a short distance of headquarters. The following hotels are recommended:

| | Minimum Rate with Bath | |
|---|---|---|
| | Single | Double |
| Bellevue | $4.00 | $ 6.00 |
| Bradford | 5.00 | 7.00 |
| Copley-Plaza | 5.00 | 7.70 |
| Kenmore | 5.00 | 9.00 |
| Manger | 4.00 | 5.50 |
| Parker House | 4.50 | 7.00 |
| Somerset | 6.00 | 10.00 |
| Statler | 5.00 | 8.75 |
| Touraine | 4.50 | 7.00 |